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THE MORALITY OF HAPPINESS.

By Thomas Foster.

[By an odd coincidence, the editor of KNOWLEDGE and I, Five of Clubs and the author of "How to Get Strong," crossed the Atlantic at one and the same time, in the steamship *City of Rome*. My own voyage has caused some delay in the appearance of my closing paper, promised for several weeks since. I was unable to complete it, as I had hoped, before leaving England. But I believe that the time which I have been able to give to the consideration of that general view of my subject which now alone remains to be presented has not been thrown away.—T. F.]

Closing Remarks.

IT remains only now that I should consider the general conclusions toward which our discussion of the subject of happiness as a guide to conduct may appear to have led us.

Let me note, yet once more, that those have entirely misapprehended the whole drift of this series of papers who imagine, as many still seem to do, that my subject has been the morality of being happy, the propriety of seeking after happiness. The mistake appears so absurd, when the nature of the reasoning I have advanced is considered, that it would seem hardly worth while to correct it, seeing that no one who could fall into such a mistake could (one would imagine) in the least profit by any explanation or correction. Yet the mistake has been made by several who are clearly not devoid of capacity alike to render and to receive a reason. I have therefore felt bound to correct it as far as possible, and, as several letters recently received show that the error is still entertained, I have now to correct it afresh. Let me explain, then, that the object of these papers has been to show what sort of moral law is likely to arise, and what law appears actually to have arisen and to be in progress of formation, when the guide of conduct is the increase of happiness,—individual happiness, and the happiness of those around us, with due regard to the proper apportionment of altruistic and egoistic happiness. I have not examined such questions as, What is happiness? What kind of happiness is worthiest? and so forth. I have taken, as included in the term "happiness," all the various forms of pleasurable emotion of which the human race is susceptible, while all the various forms of painful emotion to which we are exposed have come naturally into consideration as all involving greater or less diminution of happiness. With the development of the human race, or of any part of the human race, in one direction or in another (for development is multiform), we find that ideas about pleasure and pain become modified in various ways. And it has been a special part of our subject to consider how the lower forms of pleasure, those related first to the physical gratification of self, and next those related specially to self, but otherwise of higher type, give place gradually to the higher gratifications arising from altruistic relations. But, apart from such considerations, our whole inquiry has been into the development of conduct by the natural operation of those laws which influence the development of happiness.

In passing I would, however, note that the law of conduct thus considered is by no means that abstraction which has been called "the happiness of the greater number," according to which each person is to regard himself and to be regarded as one, while the rest, being many, are to be regarded as of very much greater importance. This abstraction has not and never had any value whatever, as a rule of conduct, either in a man's self or in his relation to others. Even if we can adopt any meaning for the word happiness as thus used, it will be found that no rational way of apportioning the happiness thus regarded as a sort of common property can be conceived. If the law instead of being an abstraction were real and could be definitely applied, it could result only in this, that each person, being but one, should utterly neglect his individual welfare in favour of the general happiness, and, as it can be readily seen that no benefits he might receive from those around him (obeying, we may assume, the same law) could possibly compensate for the direct and immediate effects of this complete self-obnegation, it *follows* that a community of persons obeying this law would be a community of miserable beings; so that obedience to this law for obtaining general happiness would in reality insure universal misery.

Taking concrete instead of abstract happiness as the guide of conduct, we recognise far different results. We see that, though there must of necessity be a compromise between egoistic satisfactions and altruistic cares, the compromise need by no means imply antagonism. Regard for the welfare of others, though in its inception more or less of an effort, becomes more and more spontaneous as social relations develop. After spontaneity has been attained, altruistic actions involve more and more of egoistic satisfaction. Conversely, the care of self, which in the earlier stages of social development appears to involve more or less of disregard for the interests of others, becomes more and more altruistic in its effect as society advances. Thus also we recognise the answer to what at first might seem a difficulty, viz., that with the improvement of social relations the opportunity for altruistic actions might seem likely to steadily diminish. We see that the domain available for altruistic actions changes in position rather than in extent; nay, that such change of extent as actually accrues is toward increase. In a society where, owing to the steady improvement of the relation between egoistic and altruistic interests, the number of those depending for their happiness or even for their existence on altruistic cares has steadily diminished, the number of those who are the subject of altruistic emotions will as steadily have increased. Sympathy becomes more widely extended, its development becomes surer and more rapid, as its operation becomes more pleasurable, and a change of this sort cannot but take place as occasions for directly altruistic actions, such as arise out of pain and suffering, become less frequent.

With increased spontaneity in altruistic actions, more

pleasurable feelings in the discharge of altruistic duties, and a wider range for altruistic emotions, will inevitably come such an evolution of conduct as must tend greatly to increase the well-being of the community. The care of self will be felt as a duty to others; due care of others will become a source of gratification to self. Society will be simply, on an enlarged scale and in a more varied form, such a community as might be formed by a number of kindly, well-meaning persons, of good capacity and pleasing manners, brought together for purposes of travel, research, or pleasure. In such a community it would be felt that each person's first duty was to take due care of self, first as just to himself, and secondly (yet chiefly) as a duty to the rest of the community. But it would also be felt by each member of such a community that he must be careful of the interests of others, ready to be of use to any other members of the community who required assistance such as he could give individually, or to combine with others where the assistance of several might seem to be required. Picture the relations of such a community, all of good-will, kindly, and anxious that the business of the community should go on so as to give pleasure to all, and it will be at once seen how little there is of actual selfishness in due care of self, how such care may be, nay, must be, a duty owed to all the rest; while, on the other hand, it will become clear also how each member of such a community is interested in the existence among all of a kindly interest on the part of each in the well-being of the rest. The social body, whether we consider the family, or the gathering of families into communities, or the collection of communities into nations, or the multitude of nations which form the population of the earth, may be regarded as an aggregate which should be pervaded by such ideas as are found essential for the comfort and happiness of gatherings casually brought together. The due subordination of self to others in certain relations, and of others to self in relations not less important, which is found in all such gatherings on a small scale and of comparatively uniform character—as in the passengers on an ocean-steamship, the members of a company of travellers, the fellows of a scientific expedition, or even a pleasure party—is what is necessary for the well-being of the body social; and out of this necessity, instinctively recognised, and exercising its influence steadily in the process of the evolution of races, nations, and the human family as a whole, seem to have sprung all those duties between man and man, between race and race, and between nation and nation, which form the present code of social morals, and will hereafter—developed and improved—form the moral code of perfected man. "What now, in even the highest natures," as the great teacher of our day says, "is occasional and feeble may be expected with further evolution to become habitual and strong; and what now characterises the exceptionally high may be expected eventually to characterise all. For that which the best human nature is capable of is within the reach of human nature at large."

"That these conclusions," Mr. Spencer goes on to say, "will meet with any considerable acceptance is improbable. Neither with current ideas nor with current sentiments are they sufficiently congruous. Such a view will not be agreeable to those who lament the spreading disbelief in eternal damnation; nor to those who follow the apostle of brute force in thinking that because the rule of the strong hand was once good it is good for all time; nor to those whose reverence for one who told them to put up the sword is shown by using the sword to spread his doctrine among heathens." From ten thousand teachers of a religion of love who are silent when a nation is moved by the religion of hate will come no sign of assent; nor from those priestly law-givers who, "far from urging the extreme precept of the Master they pretend to follow, to turn the other cheek when one is smitten, vote for acting on the principle, Strike lest ye be struck. Nor will any approval be felt by legislators who, after praying to be forgiven their trespasses as they forgive the trespasses of others, forthwith decide to attack those who have not trespassed against them. But though men who profess Christianity and practice Paganism can feel no sympathy with such a view, there are some, classed as antagonists to the current creed, who may not think it absurd to believe that a rationalised version of its ethical principles will eventually be acted upon."

Finally, I would ask those who have followed me thus far to note how all the duties we have considered, both egoistic duties and altruistic ones, may be seen with advantage from a different point of view and in a changed aspect, though unchanged in reality. We are in the habit of regarding the study of moral laws always from the personal side, and nearly all teachers in such matters (one might almost say all) view the subject in this way, since, even when laying down a code of morals, they present each law as it appeals to the reason and should affect the conduct of the individual. But it should be remembered that a moral law which commends to each man a particular line of conduct, is a law which, if accepted and followed by all, influences each man by the effect it produces on all the rest. Thus, a rule of conduct seemingly egoistic, and really egoistic as affecting the individual, becomes, in any society which accepts and obeys it, purely altruistic in its effect; while, *per contra*, a law seemingly altruistic in terms becomes purely egoistic in influence. If, instead of indicating a due regard for self and a proper subordination of self to others, our study of the morality of happiness had indicated as best for the community a series of duties directed solely to the benefit of self, yet the adoption of such a moral code by all men would be altogether unselfish, seeing that it would mean the forsaking of all right or title to help or sympathy from others; and others are many, while self is but one. If, on the other hand, we had found a system of perfect altruism commending itself as best, the acceptance of such a system would be no sacrificing of self to others, but would mean the acceptance of the principle that every one else was bound to assist in all his ways and wishes the accepter of this seemingly altruistic code—to sympathise with him in all his sorrows, and to care for him far more than for themselves. We have not been led to recognise any such abnegation of self on the one hand, or regard for self alone on the other hand, as desirable; but, in such degree as we have seen a regard for self to be desirable, we have in reality been led to the recognition of the rights of others (since each self is another to all others), while, in such degree as we have seen that each should consider not only the rights but the requirements of others, we have been led in reality to the recognition of the rights of each man to the assistance and sympathy of his fellows.

THE SEA HORIZON.

By Richard A. Proctor.

IT is amusing to note how ignorant many ordinary seamen and nearly all sea travellers are of such matters as the distance of the sea horizon, the way in which a ship's place at sea is determined, and other such matters—which all seamen might be expected to understand, and most persons of decent education might be expected to have learned something about at school. Ask a sailor how

far off a ship may be, which is hull down, and he will give you an opinion based entirely on his knowledge of the ship's probable size, and on the distinctness with which he sees her. This opinion is often pretty near the truth; but it may be preposterously wrong if his idea of the ship's real size is very incorrect, and is sometimes quite wrong even when he knows her size somewhat accurately. Any notion that the distance may be very precisely inferred from the relative position of the hull and the horizon line seems not to enter the average sailor's head. During my last journey across the Atlantic we had several curious illustrations of this. For instance, on one occasion a steamer was passing at such a distance as to be nearly hull down. From her character it was known that the portion of her hull concealed was about 12 feet in height, while it was equally well known that the eye of an observer standing on the saloon-passengers' deck on the *City of Rome* was about 30 feet above the water-level. A sailor, asked (by way of experiment) how far off the steamer was, answered, "Six or seven miles." "But she is nearly hull down," some one said to him. "I didn't say she warn't, as I knows on," was the quaint but stupid reply. Now, it might be supposed to be a generally-known fact that even as seen from the deck of one of the ordinary Atlantic steamers, the horizon is fully six miles away, the height of the eye being about 18 or 20 feet, and that for the concealed portion of the other ship's hull a distance of four or five miles more must be allowed: so that the man's mistake was a gross one. And several other cases of a similar kind occurred during my seven days' journey from Queenstown to New York.

The rules for determining the distances of objects at sea, when the height of the observer's eye and the height of the concealed part of the remote object above the sea-level are both known, are exceedingly simple, and should be well known to all. Geometrically, the dip of the sea surface is eight inches for a mile, four times this for two miles, nine times for three miles, and so forth; the amount being obtained by squaring the number of miles and taking so many times eight inches. But, in reality, we are concerned only with the optical depression, which is somewhat less, because the line of sight to the horizon is slightly curved (the concavity of the curve being turned downwards). Instead of eight inches for a mile, the optical depression is about six inches at sea, where the real horizon can be observed. But, substituting six inches for eight, the rule is as above given. Six inches being half-a-foot, we obtain the number of six-inch lengths in the height of an observer's eye by doubling the number of feet in that height; the square root of this number of six-inch lengths gives the number of miles in the distance of the sea horizon. Thus, suppose the eye of the observer to be eighteen feet above the sea level; then we double eighteen, getting thirty-six, the square root of which is 6; hence the horizon lies at a distance of six miles as seen from an elevation of 18 feet. For a height of 30 feet, which is about that of the eye of an observer on the best deck of the *City of Rome*, we double 30, getting 60, the square root of which is 7·7; hence, as seen from that deck the horizon lies at a distance of 7 7-10 miles. If the depth of the part of a distant ship's hull below the horizon is known, the distance of that ship *beyond the horizon* is obtained in the same way. Thus, suppose the depth of the part concealed to be 12 feet, then we take the square root of twice 12, or 24, giving 4·9, showing that that ship's distanee beyond the horizon is 4 9-10 miles. Hence, if a ship is seen so far hull down, from the hull of the *City of Rome*, we infer that its distance is 4 9-10 miles beyond the distance of the horison, which we have seen to be 7 7-10 miles—giving for that ship's distance 12 3-5 miles. And with like ease may all such cases be dealt with.—*Newcastle Weekly Chronicle.*

THE SENSE OF TASTE.

By Grant Allen.

ANIMALS eat, and, broadly speaking, one may say that a better popular definition of what is most essential to the idea of an animal as opposed to a plant could hardly be found than this habit of eating. In all the higher animals, at least, to eat implies a mouth—a special organ for the reception and often for the trituration of the natural food. This mouth is usually supplied with a tongue or discriminative service, the object of which is to enable the animal at once to distinguish between food that is good for it and food that is useless or positively injurious. The sense by which the animal thus discriminates between possible and impossible foodstuffs is called the sense of taste.

The lowest animals hardly need a sense of taste at all, at least in the developed form here contemplated; all is fish that comes to their net; they swallow and, if possible, digest every bit of organic matter they happen to come across in the course of their aimless peregrinations. Or, rather, they swallow whatever is smaller than themselves, and get swallowed by whatever is larger. Still, even in these lowest depths of animal evolution, we get in a very simple and undeveloped form some first faint foreshadowing of the faculty which becomes specialised later on into the sense of taste. When floating jelly-bag meets floating plantlet or floating jelly-speck under the microscope, it makes an effort to envelope the edible morsel all round with its own matter. But when it meets mineral bodies or uneatable things generally, it either does not try to envelope them at all, or if it coats them for a moment it soon rejects them as of no practical use for its own purposes. These simplest rudimentary animals, besides being all mouth and all stomach, are also all nerve and all sense-organ. Every part of them seems to possess in some feeble manner the power of discriminating between what is food and what is useless.

In the higher animals, side by side with the evolution of a definite mouth, jaws, teeth, stomach, and digestive and assimilative mechanism generally, the power of discriminating food has been specialised and localised in the tongue, at the very front of the alimentary canal. In each species of animal, natural selection has ensured that the nerves of the tongue should correctly in the main inform the animal what food-stuffs were desirable for it, and what were undesirable. Clearly if it were conceivable that a race of animals should be so constituted that it liked poisons and disliked nutritious substances, that race must rapidly die out and leave no survivors. On the other hand, just in proportion as a race finds the indications of its sense of taste in harmony with the physiological effects of things swallowed in that proportion must it tend (other things equal) to prosper in life, and to hand on its own discriminative powers to later generations.

In the human species the gustatory tract has been divided by Prof. Bain into three regions, each of which has its own special and proper functions to perform in the economy of tasting. The tip of the tongue is mostly supplied with nerves which are really rather nerves of touch than nerves of taste, and which are cognisant for the most part of pungent, acrid, or saline bodies. Obviously this arrangement conduces to the greatest safety of the

mouth and stomach. The very first thing we want to know about any substance which we think of swallowing is whether it is immediately destructive of the bodily tissues. Now, the nerves of touch distributed to the tip of the tongue instantly inform us on this important primary question. In tasting an unknown substance, indeed, we all of us instinctively try it beforehand by touching it very lightly with the tip of the tongue. If it is caustic, like vitriol, or pungent, like cayenne and mustard, or fiery, like spirits of wine, or warping, like borax or alum, the tip of the tongue instantaneously warns us that it is not a fitting substance to be swallowed wholesale. This chemical sensibility of the nerves of the tongue is only a modified form of the general chemical sensibility of the whole body. Mustard, made into a plaster, acts on the skin very much as it acts on the tongue, only less rapidly and less specifically. The warping effect of alkalies can be felt on any part of the body, and the fiery character of alcohol faintly affects the nerves of touch in the same manner as the nerves of taste. In short, the sensitiveness of the tongue in this respect is only an intensified form of the common sensitiveness of nerves generally.

When a substance has passed the first examination with the tip of the tongue, and has been pronounced harmless, it is handed over to the middle region, supplied with the nerves of taste proper. It is the special function of these nerves to discriminate between sweet and bitter objects, as well as between various tasty substances which we know distinctively as flavours. On the whole, it is clear that human beings like sweets, that the tongue responds favourably to the class of foods which contain sugar as a principal element. The reason for this strongly-marked preference is probably to be found in the ancestral fruit-eating habits of our race. To our early arboreal progenitors fruits were, of course, almost the only sweet objects known; they had as yet no sugar factories, and they doubtless seldom tasted even honey in the honey-comb. Hence it was natural that the presence of sugar should come to be the instinctive test, as it were, for the edibility of whatever object they happened to come across. In our modern artificial condition, where we use sugar to excess, and often in too concentrated forms, taste alone no longer acts as a safe guide; as children we eat too many sweetmeats, and in adult life we have no digestions: but that is only because we have altered the natural conditions, and have separated the sugar from the other wholesome food with which it is usually combined under its original circumstances. On the other hand, almost all bitter substances in the vegetable world are known to be poisonous, and our repugnance to bitter tastes is thus due to the registered experience of countless generations of early human or præ-human ancestors.

The third and lowest region of the tongue is the one cognisant of pleasures and pains in immediate sympathy with the stomach. The feelings we experience in this part of our throats can scarcely be properly described as tastes; they are best characterised, in Professor Bain's well-chosen language, as Relishes and Disgusts. When we have begun to chew a piece of wholesome beef-steak in healthy hunger, we are conscious of a certain pleasurable sensation as it reaches the back of the tongue which induces us to persevere with the action of swallowing, and finally commit it to the digestive apparatus. On the other hand, when we take a dose of cod-liver oil, we are conscious, at the same stage in the proceedings, of a certain physical repulsion to the act of swallowing it; something seems to rise up instinctively in the throat which warns us that cod-liver oil is a remarkably difficult substance to digest and assimilate. The sensations thus experienced are purely premonitory of the effect of the food taken upon the stomach. Accordingly, they vary much, according to our state of health or appetite. However seasick we may be, pungent things are still pungent to us, acid things acid, bitter things bitter, and sweet things sweet. But meat, fat, oils, and so forth, produce effects very different from their ordinary results. The tastes discriminated by the lower part of the tongue are all of this character; and the things which find it most difficult to pass the final examination here are tainted or putrid meats, very rich or buttery dishes, and other indigestible or bilious substances.

Thus we may say roughly that the threshold of the mouth warns us against whatever will prove absolutely destructive to the tissues generally; the central region distinguishes between what is ordinary human food, and what is poisonous or otherwise deleterious when taken internally; and the lower portion of the tongue and throat pronounces finally upon the digestibility and fitness for the stomach (in its passing condition) of the food which has successfully passed the two earlier preliminary examinations.

THE ORIGIN OF SILK.

IF we put any trust in tradition, says an English journal, there is a legend that Tchin, the eldest son of Japhet, father of the Asiatic race, taught his children the art of preparing silk, as well as the arts of painting and sculpture. Be this as it may, it is certain that, about 3,000 years before the Christian era, a Chinese book, the "Ghou-King," described silken cords, which were stretched upon a musical instrument invented by the Emperor Fo-Hi. One of his successors, Chin Nong, reputed inventor of the plough, explained to his contemporaries what beautiful stuffs could be obtained by cultivation of the mulberry tree, and about the year B.C. 2600 an empress, to whom a grateful posterity assigned a place in a celestial constellation, perfected the art of unravelling the cocoon and weaving. From that time silk culture had its principal seat near the northern portion of the Yellow River, in the province of Chan-Tong. There was produced silk for the Royal household. Yellow was the chosen colour for the emperor, empress, and prince imperial; violet for the other wives of the emperor, blue for distinguished officers, red for those less conspicuous, and black for everyone else. In the book of rites, "Li-Ki," the ceremonies performed at the harvest are carefully described. Even the empress did not disdain to gather the leaves of the mulberry with her own dainty fingers, and watched over the rearing of the busy toilers of the cocoon.

For a long time this invaluable industry remained the exclusive property of the Chinese empire, but about the third century before the Christian era a military expedition from China bore the results of its civilisation to the startled Occident. Silk became known in Persia and India, and was at last brought to Europe. The soldiers of Crassus, B.C. 56, saw silken standards among the Parthians, and a few years later an immense velarium of silk protected the spectators in the Roman circus from the rays of the sun. From this time the Romans were always provided with the beautiful textures which were the admiration of their legions. Yet silk was still the privileged possession of the rich, and in the time of Aurelian, who flourished in the third century, was worth about forty times its present value. The enormous price, when considered with the fact that there was at that time no commerce between Rome and the Orient, goes far towards explaining the great hoarding of treasure and jewellery which has since that time gone on in India.

There is a dispute between tradition and history as to the period when the genuine cocoon was brought from China to Europe. How was the vigilance of Celestials thwarted, since exportation of the silkworm from the Flowery Kingdom was forbidden under the severest penalties? One account states that in A.D. 552, two monks sent to Kothan by Justinian, succeeded in bearing away their booty concealed in a stalk of bamboo. The legend says that once upon a time, when Kothan did not yet possess the precious bombyx, the King of one of the provinces sought and obtained a daughter of the Chinese Emperor in marriage. Before quitting her native land she hid seeds of the mulberry and silkworms' eggs in her hair, where it would escape the vigilance of the Customs officers on the frontier. When she reached her new home she planted the seeds of the mulberry in order that suitable nourishment might be provided in the leaf for the worms.—*The Dyer and Calico Printer.*

DREAMS:

THEIR PLACE IN THE GROWTH OF PRIMITIVE BELIEFS.

By Edward Clodd.

VI.

TO the savage mind no other explanation of illness is possible than that it is due to the exit of one's own spirit or to the intrusion of a stronger one, whether of revengeful man or animal. An old Dacotah, whose son had sore eyes, said that nearly thirty years before, when the latter was a boy, he fastened a pin to a stick and speared a minnow with it, and it was strange that after so long a time the fish should come to seek revenge. When an Indian is attacked by any wild beast, he believes that the avenging Kenaima has transferred his spirit to the animal which seizes him, and if he has even a toothache, of which more presently, then the Kenaima has insinuated himself in the shape of a worm. The tribal chief among the Brazilian natives acts as doctor, and when he visits the sick, he asks what animal the patient has offended, and if no cure is effected, the convenient explanation is at hand that the right animal has not been found. At the death of Iron Arms, a noted North American Indian warrior, it was said that he died because the doctor had made a mistake, thinking that a prairie-dog had entered him when it was a mud-hen. The more abnormal and striking phases of disease manifest when a man is writhing under intense agony, as if torn and twisted by some fiendish living thing, or when in delirium he raves and starts, or when thrown down in epilepsy he struggles convulsively, or when he shivers in an ague, or when in more violent forms of madness he seems endowed with superhuman strength; the various symptoms attending hysteria; each and all support that theory of spirit-influence which survives among advanced races in referring disease to supernatural causes. For the ancient theories of a Divine government under which disease is the expression of the anger of the gods, and medicine the token of their healing mercy; and the current notions that any epidemic or pestilence is a visitation of God, are identical in character, however improved in feature, with the barbaric belief illustrated above; and in the ages when belief in the devil as one walking to and fro upon the earth was rampant, he especially was regarded as bringer of both bane and antidote. "He may," says an old writer, "inflict diseases, which is an effect he may occasion *applicando activa passivis* (by applying actives to passives), and by the same means he may likewise cure . . . . and not only may he cure diseases laid on by himself, as Wierus observes, but even natural diseases, since he knows the natural causes and the origin of even those better than the physicians can, who are not present when diseases are contracted, and who, *being younger than he*, must have less experience." In Lancashire folk-lore "casting out the ague" was but another name for "casting out the devil"; in the Arabic language the words for epilepsy and possession by demons are the same; and in such phrases as a man being "beside himself," "transported," "out of his mind," or in the converse, as when it is said in the parable of the prodigal son, "he came to himself"; in the words ecstasy, which means a displacement or removal of the soul, and catalepsy, a seizing of the body by some external power, we have language preserving the primitive ideas of an intruding or departing spirit. Such minor actions as gaping and sneezing confirm the belief. The philosophy of the latter, as Mr. Gill remarks in his "Myths and Songs of the South Pacific," is that the spirit having gone travelling about, its return to the body is naturally attended with some difficulty and excitement, occasioning a tingling and enlivening sensation all over the body. And the like explanation lies at the root of the mass of customs attendant on sneezing, and of the superstitions generated by it, which extend through the world.

Williams tells us that among the Fijians, when any one faints or dies, their spirit, it is said, may sometimes be brought back by calling after it, and occasionally the ludicrous scene is witnessed of a stout man lying at full length and bawling out lustily for the return of his soul. So in China, when a child is lying dangerously ill, its mother will go outside into the garden and call its name, in the hope of bringing back the wandering spirit. But for all the ills that flesh is heir to—from hiccupping to madness, from toothache to broken limbs—the patient seldom dares to doctor himself; neither the etiquette of the ordained medicine-man nor the orthodox therapeutics favour that show of independence. The methods adopted by the faculty vary in detail, but they are ruled by a single assumption. When a Chinaman is dying, and the soul is believed to be already out of the body, a relative holds up his coat on a bamboo stick, and a Taoist priest seeks by incantations to bring back the truant soul so that it may re-enter the sick man. Among the Six Nations the Indians sought to discover the intruder by gathering a quantity of ashes and scattering them in the cabin where the sick person was lying. A similar recipe for tracking demons is given in the Talmud; but, as more nearly bearing on the Indian practice, a Polish custom mentioned by Grimm* may be quoted. When the white folk torment a sick man, a friend walks round him carrying a sieveful of ashes on his back, and lets the ashes run out till the floor round the bed is covered with them. The next morning all the lines in the ashes are counted, and the result told to a wise woman, who prescribes accordingly. A favourite mode of treatment is blowing upon or sucking the diseased organ, and deception is no infrequent resort when the sorcerer secretes thorns or fishbones, beetles or worms, in his mouth, and then pretends that he has extracted them. Cranz says that the Eskimaux old women appear to suck from a swollen leg scraps of leather or a parcel of hair which they have previously crammed into their mouths, and in Australia the same dodge is practised, when the sorcerer makes believe that he has drawn out a piece of bone from the affected part. That toothache is due to a worm, is a belief which exists throughout Europe

* "Teut. Mythol.," 1165.

and Asia, and from the Orkneys to New Zealand. Shakespeare refers to it in "Much Ado about Nothing," act iii., sc. 2:—

> *Don Pedro.* What! sigh for the toothache?
> *Leonato.* Where is but a humour or a worm.

and instances are current of this superstition being acted upon in rural districts, whilst in China the itinerant dentist conceals a worm in the stick which he applies to the aching tooth, and on the stick being gently tapped, the worm wriggles out to the satisfaction of the sufferer. But among barbaric races the treatment is ordinarily the reverse of soothing. Here and there the virtues of some plant have been discovered by accident, and, whilst exalted into a deity in its native home, it has become, like cinchona, a priceless boon to the fever-stricken all over the world; but, speaking broadly, the medicine-man is no Melampus, winning the secret of their healing balm from herb and tree. Nor has he much faith in magic or charm compared to his faith in noise, in incantations, with their accompanying hideous grimaces and gestures, and their deafening yells with clang of instrument to drown the sufferer's groans and chase away the demon. Not unfrequently, when the patient is kept without food so as to starve out the indwelling enemy, or when the body is pommelled and squeezed to force him out, the remedy helps the disease! An illustration or two from a great mass at command must suffice. Among the Mapuches the sorcerer adopts the canonical howls and grimaces. Making himself as horrible-looking as he can, he begins beating a drum and working himself into a frenzy until he falls to the ground with his breast working convulsively. As soon as he falls, a number of young men outside the hut, who are there to help him in frightening the disease-bringing spirit out of the patient, add their defiant yells, and dash at full speed, with lighted torches, against the hut. If this does not succeed, and the patient dies, the result is attributed to witchcraft. When a Pawnee chief had some ribs and an arm broken, the medicine-men danced round him, and raised their voices from murmurous chants to howls, accompanying the music (?) by blows upon the wounded man's breast to banish the bad spirit. In olden time this rough-and-tumble business of blows, to which immersion was added, was applied to lunatics in these islands. And, in fact, until some local paper narrates a current superstition, we seldom awaken to the fact how widely the theological explanation of diseases and the empirical choice of remedies still obtains, each being survivals of barbaric theory and practice.

The savage who has more faith, as a curative, in plants that grow on burial-places, and the civilised, who ascribes special healing power to turf and dew from a saint's grave, differ no whit in kind; and so ingrained was the medicinal belief in virtue inhering in fragments of the dead, that not even the satire of "Reynard the Fox," telling how the wolf was cured of his earache, and the hare of his fever, the moment that they lay down on the grave of the martyred hen, could give quietus to the notion that grated skulls and sacramental shillings were specifics for the healing of the faithful.

This reference to like practices reminds us how belief in the action of invisible agencies has passed into the practice of confession among advanced races outside Christendom, as in Mexico and Peru. The Roman Catholic priests were not less astonished at finding this in vogue on their arrival in South America than the good Father Huc when, on reaching Tibet, he found shaven monks wearing rosaries, worshipping relics, using holy water, and a grand Lama decked in mitre, cope, and cross.* But, as the Italian proverb has it, the world is one country and "we have all one human heart," so that the confessional has the like explanation in east as in west. If the disease be the work of an offended deity or of an avenging spirit, let the wrongdoer admit his fault, and trust to him who is credited with influence with the unseen to exorcise the intruder.

THE EARTH'S SHAPE AND MOTIONS.†

By Richard A. Proctor.

INTRODUCTION.

IN many works of astronomy the subject of the earth's figure and motions is dealt with at greater or less length; the general principles on which modern views are founded are exhibited with sufficient clearness; and a number of facts quite sufficient to establish the justice of modern theories are quoted in illustration. But it has always seemed to me that the way in which such matters are commonly presented, is open to objection. Either from a desire to simplify the subject, or for some other reasons, the facts are stated in a general way, which is in reality much more perplexing to the beginner than an exact statement would be, besides being open to cavil and objection. The full force of the observational or experimental evidence on which modern views have been founded, is lost to the student, when the results are stated without a careful reference to quantity and measure. The impression is too commonly left, that those inexact and unsatisfactory results are in reality all that astronomers have been able to gather; and when it is seen that such results admit of being explained in other ways, doubts naturally spring up as to the exactness of modern astronomy.

This would be less important, were it not that there is a class of persons very ready to profit by this state of things. Knowing perfectly well that the world is always more ready for novelty, than to hear the details of real scientific progress, these persons invent hypotheses of greater or less ingenuity, which appear to be consistent enough with the relations described in books on astronomy. These hypotheses they further recommend to the public notice by garbled extracts from the works of known authors, or by apocryphal experiments. Secure of a large audience for their absurdities, they little regard the contempt which all well-informed persons bestow on them. They invite controversy, confident that no student of science, who considers his own reputation, will enter the lists with them, and safe also (even if such an improbable event should occur) in the certainty that by a few verbal evasions they will be able to avoid the appearance of defeat.

There is also another class of persons equally anxious to promulgate new theories, but not absolutely dishonest. Among the thousand who, having read the ordinary popular works on astronomy, remain unconscious of the exactness of modern science, there are necessarily some who mistake their want of apprehension for exceptional ability. Such persons, especially if they are troubled by the *cacoethes scribendi*, promulgate new theories with a surprising fecundity. Scarcely a month passes that a work involving some new absurdities does not pass through the press. And these books find purchasers who are at least

* "Voilà autant de rapports que les Bouddhistes ont avec nous," adds the traveller, for hinting at which analogies between Buddhists and Catholics the Pope put his book on the Index.

† The papers which follow are revised versions of a series which appeared seventeen years since in the *English Mechanic*.

as likely to adopt the new views as to retain their confidence in the modern system of astronomy.

I would not have it understood that the present series of papers is in any way intended as an answer to the paradoxists—whether of the honest or of the dishonest school. To enter into controversy with these writers would be not only a foolish, but a wrong thing to do. It would imply that modern astronomy, and—which is more important—the professors of modern astronomy, require to be defended. The task would also be necessarily a vain one, since the honest paradoxist cannot, and the dishonest paradoxist will not see the futility of their arguments. Nor does either class, indeed, deserve to be answered, since even the honest paradoxist—though otherwise to be commiserated—yet merits condemnation for professing to teach matters which he has not mastered, and so leading others astray.

It is for the benefit of those who really wish to know something of the grounds on which the modern system of astronomy rests, that I pen these papers. I wish to indicate the way in which the various parts of the evidence dovetail into each other, and to show how observed facts are accounted for, not merely in a general way, but in measure and quantity—the only true test of a theory. Lastly, I may find occasion in passing to notice some of those absurd hypotheses which now, as at any time since Newton's day, find supporters and believers.

A large part of the evidence I shall present to the reader is such as he can himself abundantly verify; but necessarily, a very large part remains which has to be taken on trust. I cannot call upon readers to take sail for the southern hemisphere and make such and such measurements or observations. I cannot ask them to devote a whole life to the study of practical astronomy, that they may be able to make those exact and delicate instrumental observations on which modern astronomy in large part depends. Nor can I insist that every one of my readers shall master the higher branches of mathematics so thoroughly that, if need were, he could follow Adams and Leverrier through all the intricate calculations by which they have extended our knowledge of the structure of the universe.

On many points, therefore, I shall have to confine myself to giving as clear and exact a statement of what is or of what has been done as I can, without being able to give evidence which can be tested, or of showing in all cases how such and such facts have been determined. In all such cases I shall have to claim the reader's trust, to ask him to believe in the exactness and honesty of modern astronomical work. Now so much has been heard from the paradoxists of the cliquism of astronomers, of their determination to uphold a false system at all costs, and of other such matters, that many have been led (absurd as it may seem), to feel doubts as to the bare honesty of the professors of modern astronomy. To all such I would say, judge astronomers in this respect as you would judge other men if you had occasion to question their honesty of purpose. Ask whether it is for the interest of astronomers to uphold a false system. Consider whether it is in accordance with what we know of human nature, that they should combine to laud the names of a Newton, a Copernicus, or a Kepler, in defiance of truth and justice.

On the first point it is easy to find an answer. The whole system of modern astronomy depends for support on the exactness with which it records or anticipates the celestial movements. Certain processes are applied for this purpose, which satisfactorily accomplish all that is required. These processes might be continued without change, though the whole system on which they were founded should be abandoned. Thus the single end and aim of practical astronomy, that purpose for which our observatories are founded, and our astronomical staff salaried, could be accomplished as well as at present, though Newton were proclaimed a charlatan, and Copernicus a cheat. So far then we see nothing to lead to the suppression of the truth, if the truth really required the overthrow of modern theories.

On the second point we can found a yet stronger claim for the confidence of our readers in the work of astronomers. Newton and Copernicus are long since dead. They can extend no patronage to the astronomer in return for the respect and admiration with which he speaks of them. To suppose that Airy, or the Herschels, Adams, Leverrier, or Hind, would praise Newton for a theory which they knew to be false, is not only to give them very little credit for honesty, it is to assert that they are blind to their own interest. If an unknown man, indeed, were to assert that Newton and Kepler were mistaken in their theories, we should, of course, pay no attention. But if Mr. Hind, for example, were to announce such a belief, he would be heard with respectful attention, and if (to conceive the inconceivable) he could establish the justice of his view, he would immediately rank high above the highest in the long list of eminent astronomers. So of any of the others I have named. On this second ground, therefore—that it is not in accordance with what is known of human nature for any man, still less for a set of men, to praise another (long since dead) for false theories, when he himself might acquire like or higher praise by overthrowing them—I confidently claim from my readers the acceptance of the results of all those observations, measurements, or experiments which have been made by modern astronomers.

The method I propose to adopt in the forthcoming pages is the same that I employed in the first chapter of my treatise on Saturn, and is in great part new. I shall show how a person wholly unacquainted with modern astronomy, might have the true relations of the earth exhibited to him in a series of simple observations. The particular order I shall select for presenting those relations might be departed from, since the subject is one which admits of a considerable variety of treatment. Other methods have, indeed, suggested themselves to me, but I believe that, on the whole, the one I have adopted is that best calculated to present the subject in a clear and satisfactory manner, within such limits as are here available.

(*To be continued.*)

THE ELECTRO-MAGNET.

By W. Slingo.

(*Continued from p. 69.*)

I AM anxious to keep clear of formulæ as far as I can, but at the same time to impart as much information as possible concerning the electro-magnet and the principles governing its structure. The two very simple equations at the end of the previous article may facilitate matters very materially. It was shown that with a coil of the relatively thick wire a current was produced, having a a strength of 1·3 ampères, and that when the diameter of the wire was reduced to one half, so as to get twice the number of turns, the current strength was reduced to ·4 ampère, or less than one-third of that attainable with the thicker wire. One of the laws of electro-magnetism is that the strength of an electro-magnet is proportional to the strength of the current. This is only true when the number of turns is the same, because each time the current circulates round the iron core it exerts its electro-magnetic effect. This law has therefore to be taken in

conjunction with another, declaring that "The strength of an electro-magnet is proportional to the number of turns of wire." Regarding these two laws together, it is clear that the thick wire coil has the greater effect, because, while there are twice the number of turns of the thin as compared with the thick wire, there may be said to be three times the current circulating through the thick as compared with the thin wire. Were the two currents made equal by modifying the battery power, then the thin wire would be twice as effective as the other. On the other hand, if while the conditions of the thin coil remained constant, the thick wire could by any means be made to encircle the core twice as often (the current being kept constant) then the threefold current circulating in the thick wire would exert three times the magnetising influence upon the core.

Even these laws, however, are not always applicable, because there is a limit to which iron or any other substance is capable of being magnetised, and the fact of there being such a limit implies that the above laws may only be regarded as applicable when the effect to be produced is considerably below this limit, which is called the "saturation point."

It was just now stated the magnetic strength varies in proportion to the number of turns. Supposing that the iron core were covered, and that no room could be found for another turn, how are we to increase that number? It might be done by coiling a wire over the previously wound coil, but what about the direction? It is evident that if we send a current round the core through a left-handed helix (as in Fig. 1), so as to make the end N a north-pole, and then send a current through an outer coil in such a manner as would induce a south-pole at N, then no polarity will be manifested unless the inducing force of one helix exceeds that of the other, in which case the magnetism induced will be a measure of the difference between these forces.

It is, however, very easy to calculate the inductive effect that would be produced by any particular coil of wire. Suppose, for example, that we are dealing with the arrangement depicted in Fig. 1, and that we wind a second left-handed helix over the core, then join a wire from the S end of the inner coil to the N end of the outer one, so that the current is made to travel in the direction indicated by the arrows through each coil in succession. Neglecting the slight increase in the length of wire involved in winding one coil over another, we shall get an external circuit having twice the resistance of the inner coil or (with the two cells).

$$\frac{E}{R+r} = \frac{4}{2+2} = 1$$

The current is thus 1 ampère as compared with 1·3, but as it passes twice as often round the core, it may be said to have an inducing power of 2 as compared with 1·3 exerted by the single coil. Here, then, an advantage is clearly gained.

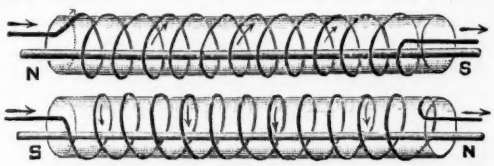
Supposing, however, that instead of connecting the two coils in series, we join them in parallel circuit—that is, by connecting the two N ends together, and likewise the two S ends. Then the current will divide at N, and, the resistance of the coils being identical, the current will divide equally, to re-unite at S. But the *joint* resistance of two equal wires is only half that of one of them, or their conductivity (the reciprocal of resistance) will be doubled. This principle has been more than once enlarged upon, so it need not further take up time here. The simple equation becomes

$$\frac{4}{\frac{1}{2}+2} = 1{\cdot}6.$$

1·6 ampères do not, however, go through each coil, but the current halving itself at N becomes only ·8 in each. Manifestly, then, a current of ·8 ampère through a certain number of turns can only have the same effect as a current of 1·6 ampères through half that number of turns.

In other words, the effect produced is the same as would result from a single coil having the same number of turns as before, but with twice the conductivity or half the resistance. This could not be obtained with the same kind of wire, because to have half the conductivity it would require twice the weight of metal. Of course, it would be possible to gain this end by using rectangular wire whose thickness in one direction is equal to the diameter of the original round wire. But even then the trouble involved would not be recompensed by the gain in inducing power, which, as pointed out, is only 1·6 as compared with 1·3.

Under the circumstances, then, the best effect is produced when the current is made to traverse the coils successively. But, on the other hand, to wind a number of individual layers, and then to connect them by longitudinal lengths of wire is out of the question, more especially as the desired effect may be more easily produced without such an arrangement.



Figs. 1 and 2.

By examining Figs. 1 and 2, the method to be employed may be readily made clear. Let us start with a layer wound, as shown in Fig. 1—that is as a left-handed helix—and let the current travel from left to right, or from N. to S. Now it has been stated (and Fig. 2 will illustrate it) that a current passing through a right-handed helix induced a north at its exit. Suppose, then, that instead of travelling from left to right, the current pursues the opposite direction, or from right to left. Then the end marked N becomes a south pole, and the end marked S a north pole. The effect thus produced is the same as that resulting from left to right through a left-handed helix. If a right-handed helix be wound over a left-handed one, and the adjacent extremities, say on the right-hand side, be connected together, then the current will pass from left to right through a left-handed, and from right to left through a right-handed, helix, when the inducing effect of each coil will harmonise, and a north pole will be produced on the left-hand side, and a south pole on the other (as in Fig. 1).

It is scarcely necessary to say that the resistance of a wire is not affected by the direction of winding, consequently the current flowing will be

$$\frac{4}{2+2} = 1$$

which (as may be gathered from what has been said above) will produce a magnetising force of 2 as compared with 1·3 resulting from either of the coils used singly. If the student takes a piece of wire or string in his hand and winds it round a rod so as to make a left-handed helix, and when he reaches the end of the rod continue the winding back to the other end without bending the wire back on itself, he will find that the second layer becomes a right-handed helix. If, furthermore, on finishing the second layer, he winds back again for a third layer, he will find that this is a left-handed helix. So, continuously winding, he generates left and right-handed helices alternately. Every

layer, therefore, supposing a current to traverse such series of coils, tends to produce a north pole at one end and a south pole at the other. This is the principle involved in the construction of electro magnets.

Before dilating upon the size and length of wire for any particular coil, let us turn our attention to the practical details of construction. It may, in the first place, be stated that, generally speaking, the best effects are produced when the length of the core is six times its diameter. Its surface should be as even as possible, not absolutely smooth, but free from marked irregularities. If such irregularities are present, they are likely to cut through or wear away the cotton or silk, whichever it may be, that is used for insulating the wire. If, again, the current is one of exceptionally high electro-motive force, there will be a considerable risk of its passing from the wire to the core, rejoining the coil at some other point. It is almost superfluous to say that when it behaves in this way, the coil might as well be absent for all the good it is capable of doing. Where any of these dangers are present the iron should either be coated with a layer of shellac varnish (made by dissolving good shellac in methylated spirit), or closely covered with paper which has been saturated with melted paraffin wax. Either of these courses will, in the great majority of cases, be sufficient to prevent the current taking a short path through the iron. The wire should be well insulated with cotton or silk, and wound as closely and regularly as possible. When the first layer is finished it should, more particularly if the wire is cotton-covered, and currents of high E.M.F. are to be used, be immersed in a bath of melted paraffin wax, and insulation is further assured by covering the layer of wire with a piece of paraffined paper. This will not want tying on or securing by extraneous means, but may be quite as effectually fixed by winding it round tightly, and then with the aid of a hot poker, or other piece of iron, heating one edge of the paper over the other. The hot iron melts the wax, which, on cooling, holds the paper firmly. The second layer may then be applied and treated in identically the same manner as the first. Layer should then succeed layer until their entire thickness equals the diameter of the core; or, in other words, until the diameter of the coil measures three times that of the core. The length of the coil will then be twice its diameter. It will be apparent that, to get the greatest possible number of layers on, so as to come within these dimensions, the space occupied by the insulating material must be as small as is practicable. An electro-magnet is then produced, care being taken, obviously, to leave free sufficient wire at the ends of the coils for purposes of connection.

Electro-magnets are very powerful, much more so than ordinary permanent steel-magnets, and are capable of producing marvellous effects. The shape of the magnet may be just whatever the experimentalist pleases, remembering, of course, that the simpler the shape the more easily will it be wound. The effects produced by magnets of equal length with equal quantities of wire are not by any means identical. Even in simple straight bar-magnets, a number of different effects may be produced, and Professors Ayrton and Perry have published particulars of very interesting experiments on this point, with which, however, as the allotted space is filled, we must deal a fortnight hence.

(*To be continued.*)

It is a sad commentary on the danger of railroading to limbs, to say nothing of the disaster to life, that the *Toledo Railroader*, the organ of the railway employés, contains the advertisements of nine different manufacturers of artificial limbs.

THE CAPTURE THEORY OF COMETS.*

By Richard A. Proctor.

We start from the conception that all comets originally entered our solar system from without. They came, says Heis, Schiaparelli, and others, who have advanced the Capture Theory, from out of interstellar space. Now, it is no valid objection to this view that it gives us no idea how cometary matter came to exist in interstellar space, for in all inquiries into the past condition of the celestial bodies we must always come short of their actual origin. Thus, in considering the past of our solar system we may start from a chaotic vaporous state, or from a past condition in the form of cosmical dust, or from a condition in which the vaporous and the dust-like forms are combined; but if we are asked whence came the vapour or the cosmic dust we are obliged to admit that we cannot tell. If, hereafter, we should be able to say that it came from such and such changes in a quantity of various forms of matter, which we may represent by X, Y, and Z, we should still be unable to say how X, Y, and Z came into existence. So that I make no serious exception against the supposed origin of comets on the ground that it really leaves very much to be explained. Interstellar space is a convenient place to which to assign the origin of bodies so mysterious as comets. *Cela exprime beaucoup de choses.* Almost anything might happen in regions of which we know so little, or, rather, of which we know absolutely nothing.

Yet it may be worth while to remark that, on the whole, the interstellar regions are less likely to be the regions whence comets originally came to visit suns and sun systems, than to be regions whither comets strayed after leaving originally the neighbourhood of solar systems. The most probable idea about the interstellar spaces is that they are the most vacuous regions within the range of the sidereal system. The mere circumstance that comets came from out of them affords no better reason for regarding them as the original home of comets, than the circumstance that comets pass from the solar system into these interstellar spaces affords for rejecting that assumption. There is, in fact, simply no reason whatever for imagining that the place where comets came into existence is the vast unknown region around the solar system which we call interstellar space. Most comets come to us from thence; as many comets are travelling into that unknown region as are coming out of it. To form an opinion about the origin of comets from no better evidence than their last journey (out of millions, very likely) can afford, would be as absurd as for a day-fly to reason that the river flowing past the home of his race came out of the sky because a few drops of rain came thence.

Suppose, however, we admit that in interplanetary space there have been in the past, and still exist, such flights of meteoric matter as the theory we are considering assumes. Let us grant them, also, such motion as may save them from what otherwise would inevitably be their fate, viz., a process of direct indrawing towards the nearest sun, and consequently destruction (with mischief probably to his orb), after a period of time which must be regarded as utterly insignificant compared with the time intervals measuring the duration of a solar system.

It follows, then, that each flight of meteors would in the long run draw near some sun, without, however, rushing directly upon him; and sweeping round his globe upon such path as chanced to result from the combination of its original movement and its attractive influence, would pass

* From an article on the "Origin of Comets," in the *North American Review*.

out again into interstellar space. This might happen tens, hundreds, thousands, or even millions of times, a comet either sweeping in a long elliptical orbit with enormous periods of revolution, around one sun; or, if its velocity were slightly greater than that supposition implies, rushing first round one sun, then out into the depths of space to visit another sun, then to yet another, and so on, flitting from sun to sun for ever, or until the kind of disturbance in which the holders of the theory we are considering believe, had changed this kind of motion into actual orbital circuit.*

In either case the minimum velocity with which a comet would be moving, when at any given distance from our sun, would be determinable within a few yards per second. It is well known that the velocity with which a body travelling to the sun from an infinite distance (though one cannot, of course, conceive such a movement) would reach the sun, would not exceed by a foot per second the velocity with which a body would reach him after travelling from the distance of the nearest fixed star. So, also, the velocities of bodies moving in orbits reaching half as far from the sun as the distance of the nearest star, would be the same within a foot or so per second as the velocities with which bodies coming to the sun from infinity would reach the same distance from him. If such bodies had originally a great inherent velocity, of course they would reach any given distance from the sun with much greater velocity. But this would not affect our estimate of the least velocity at that distance. Thus we know what the giant planets to which has been attributed the final capture of those comets which now form a part of the solar system, had to do. We can tell the precise velocity in miles per second, or, at least, the minimum velocity, with which our imagined meteoric flight would cross the orbit of Neptume, or Uranus, or Saturn, or Jupiter, as the case might be, before its capture. We know, in the case of each comet supposed to have been captured, the precise velocity of the comet at the distance of the planet which captured it,—its special planet-master. The difference is the amount of velocity which the capturing planet had to take away in order to effect the supposed capture.

Observe that we are here on sure ground, if the theory is sound. It is certain that a comet in coming from remote interstellar space to the solar system would have at the distance, say, of Jupiter, a certain velocity. It is certain that a comet now travelling in a particular orbit, approaching at one point very near to the orbit of Jupiter, has at Jupiter's distance a certain velocity, very much smaller. Hence, it is certain that, if Jupiter captured that comet by disturbing it as it approached him on the last of its many free visits to the sun, the giant planet must have deprived the comet of so many miles per second of its former velocity. All we have to do is to find out how the planet could do this; in other words, how near the comet must have approached the planet to be thus effectively disturbed.

These columns are not suited for the close and exact discussion of the case of any particular comet. I have elsewhere (in a paper which appeared in the "Proceedings" of the Astronomical Society) given the details for certain cases which have been regarded as among the most satisfactory illustrations of the comet-capturing ways of the giant planets, and have shown that the theory is in those cases, and therefore in all, absolutely untenable, though so resolutely held. Still it may be well here to consider an illustrative general case—the simplest that can be taken, and also the most effective, because the conditions are, in reality, much more favourable than they are in any known case.

Imagine a flight of meteors to travel from interstellar space toward the sun until it reaches the distance of Jupiter, and that when at that distance it chances to pass very close to the orbit of Jupiter, and at a time when Jupiter himself is very near the place where the meteor flight crosses his track. Observe that the chances against each one of these contingencies are enormous. If we conceive a sphere around the sun, girdled by Jupiter's orbit, the meteor flight in its course sunwards might traverse the surface of that sphere (or, which is the same thing, might traverse the part of its course where it is at the same distance as Jupiter from the sun) anywhere, and we are supposing that it traverses that surface close to a particular girdling circle (technically a "great circle" of the sphere). Suppose that by "close" we mean within a million miles; then the imaginary girdle of the sphere through which the meteor flight must pass to fulfil the required conditions is two millions of miles broad. The sphere itself has a diameter of some nine hundred and sixty millions of miles, and by a well-known property of the sphere,* its surface is four hundred and eighty times greater than that of the girdling strip. The chance is but one in four hundred and eighty than any meteor flight coming from interstellar space toward the sun will be within a million miles of Jupiter's orbit when at Jupiter's distance from the sun. Then Jupiter's path has a circuit of more than three thousand millions of miles. Thus the chance that at the moment of the meteor flight's passing the orbit, Jupiter will be within a million miles on either side of the place of passage, is as two in three thousand, or one in one thousand five hundred. But the chances that both these relations hold is only as one in one thousand and five hundred multiplied by four hundred and eighty, or as one in more than seven hundred thousand. Thus, assuming—though the case is otherwise—that a million miles would be an approach near enough for capture, still only one meteor flight out of seven hundred thousand which come from outer space could be captured by Jupiter.

This, however, is but the mere beginning. We may admit that millions of times as many comets or meteor flights approach our system as the planets have captured; and if so, we need recognise no special force in any such considerations as have just been presented. I have only advanced them to suggest the conditions which are, as it were, essential for the process of comet capturing by a giant planet.

(To be continued).

* I have here considered only two kinds of cometic orbit, the elliptic and the hyperbolic; for a true parabolic orbit would be as unlikely, or rather as impossible, as a truly circular orbit among the planets.

* The property is this: that the surface of a sphere exceeds the surface of a girdling strip, such as we are considering, in the same degree (if the strip is relatively narrow) that the diameter of the sphere exceeds the breadth of the strip.

MIND IN MAN AND BRUTE.†

By George J. Romanes.

IF it is true "The proper study of mankind is man," assuredly the study of nature has never before reached a territory of thought so important in all its aspects as that which, in our own generation, it is now for the first time approaching. After centuries of intellectual conquest in all regions of the phenomenal universe, man has at last begun to find that he may apply in a new and most unex-

† From an article on "Man and Brute," in the *North American Review*.

pected manner the age of antiquity, "Know thyself." For he has begun to perceive a strong probability, if not an actual certainty, that his own living nature is identical in kind with the nature of all other life, and that even the most amazing side of that nature—nay, the most amazing of all things within the reach of his knowledge—the human mind itself, is but the topmost inflorescence of one mighty growth, whose roots and stem and many branches are sunk in the abyss of planetary time.

The problem, therefore, which in this generation has now, for the first time, been presented to human thought, is the problem of how this thought itself has come to be. A question of the deepest importance to every system of philosophy has been raised by the study of biology, and it is the question whether the mind of man is essentially the same as the mind of the lower animals, or, having had, either wholly or in part, some other mode of origin, is essentially distinct, differing not only in degree, but in kind, from all other types of physical existence.

First, then, let us consider the question on purely *à priori* ground. The process of organic and of mental evolution has been assumed to be continuous throughout the whole region of life and of mind, with the one exception of the mind of man. On grounds of a very large analogy, therefore, we should deem it antecedently improbable that the process of evolution, elsewhere so uniform and ubiquitous, should be interrupted at its terminal phase; and I think that, looking to the very large extent of the analogy, this antecedent presumption is really so considerable that it could only be fairly counterbalanced by some very cogent and unmistakable facts, showing a difference between animal and human psychology so distinctive as to render it in the nature of the case virtually impossible that one could ever have graduated into the other. This I posit as the first consideration.

Next, still restricting ourselves to the *à priori* aspect of the matter, it is unquestionable that human psychology in the case of every individual human being presents to actual observation a process of gradual development, or evolution, extending from infancy to manhood; and that in this process, which begins at a zero level of mental life and may culminate in genius, there is nowhere and never observable a sudden leap of progress, such as the passage of one order of psychical being into another distinct in kind might reasonably be expected to show. Therefore, it is a matter of observable fact that, whether or not human intelligence differs from animal in kind, it certainly admits of gradual development from a zero level; and to this we must add that, so long as it is passing through the lower phases of that development, it assuredly ascends through a scale of mental faculties which are *pari passu* identical with those that are permanently presented by the psychological species of the animal kingdom. These facts, which I present as a second consideration, tend still further, and I think most strongly, to increase the force of the antecedent presumption against the process of evolution having been discontinuous in the region of mind.

Again, it is likewise a matter of actual observation, that in the history of our race, as recorded in documents, traditions, antiquarian remains, and flint implements, the intelligence of the race has been subject to a steady process of gradual development—a general fact which admits of any amount of special corroboration by comparing the psychology of existing savages, where the process of evolution in the past has not been so rapid or has in part been arrested, with that of civilised man. This is the last consideration that I shall adduce of the *à priori* kind, and its force consists in the fact of its proving that if the process of mental evolution was interrupted between the anthropoid apes and primitive man, it must again have recommenced with primitive man, and since then have continued as uninterruptedly in the human species as it previously did in the animal species. This, to say the least, upon the face of the indisputable facts, or from a merely antecedent point of view, appears to me a highly improbable supposition. At all events, it certainly is not the kind of supposition which men of science are disposed to regard with favour elsewhere; for a long and arduous experience has taught men of science that the most helpful kind of supposition which they can bring with them into their investigations of nature is that kind of supposition which recognizes in nature the principle of continuity.

Taking, then, all these *à priori* considerations together, they must, in my opinion, be fairly held to make out a very strong *prima facie* case in favour of the view that there has been no interruption of the developmental process in the course of psychological history, but that the mind of man, like the mind of animals—and, indeed, like everything else in organic nature—has been evolved. For these considerations show, not only that on analogical grounds any such interruption must be held as in itself improbable; but, also, that the human mind unquestionably admits of having been slowly evolved from the zero level, seeing that in every individual case, and during many past millenniums in the history of our species, the human mind actually does and has undergone the process in question.

In order to overthrow so immense a presumption as is thus erected on *à priori* grounds, the psychologist must fairly be called upon to supply some very powerful considerations of an *à posteriori* kind, tending to show that there is something in the constitution of the human mind which renders it impossible, or, at all events, exceedingly difficult, to imagine that it can have a genetic relation to mind of lower orders.

NATURAL GAS FUEL AT PITTSBURG.

At the recent meeting of the American Society of Mechanical Engineers at Pittsburg, the report of the committee appointed to investigate the whole subject of natural gas was made, and many interesting particulars, we read, were given.

Though Pittsburg is within reach of three or four prolific localities, and gas has been used for many years, it is but recently that any organised effort has been made to use it on a large scale. Already there are 150 companies chartered in the State, representing over 2,000,000 dols.; and gas is brought from eight to twenty-five miles for use in the city. Five-inch mains are being followed by 8-inch, new wells are being bored, and the time when Pittsburg shall become a smokeless city may not be far distant. Though the gas is used under a pressure of a few ounces, the pressures at the wells run from 50 to 125 pounds; this is due to the friction in the mains, five pounds being allowed for each mile. If the flow be shut off the pressure runs up much higher, and great difficulty has been experienced in making tight joints; cast iron is too porous, and ordinary pipe-threads do not fit well enough. A number of new coupling devices were exhibited, in some of which a lead packing was used. No allowance for expansion need be made, as the gas maintains an even temperature of about 45° Fah. When gas is allowed to burn freely at the mouth of a well, the cold produced by the expansion is such that ice has been projected through the flames.

The gas is used in all kinds of furnaces for making steam iron, glass, &c.; and electric light carbons, and the finest

lampblack for printing inks is made from it; but it is used with suicidal wastefulness, which causes anxiety, as many wells give out in less than five years. The report looks to its economic and safe control. For household use, it might otherwise be dangerous, and such use has commenced, though no practicable method of deodorising it has been found. Being composed largely (96 per cent.) of marsh gas, its value as a heating agent is high, and its density is about half that of air. One pound (23·5 cubic feet) of gas has a theoretical evaporating power of 24 lb. of water, 20 lb. having been actually evaporated. The best method of burning it is not generally known; experiments with injector burners show that they do not suck in sufficient air for complete combustion, and the best results have been from numerous jets in contact with the whole heating surface of the boiler. The value of the gas, as compared by evaporation tests with coal at $1.40 per ton, is only 8 cents per thousand feet (which suggests that even our ordinary gas companies make profits), but its use is immensely more convenient; no stacks are needed, and the furnace reduces to a simple non-conducting chamber. The gas has just been turned on to the city waterworks. On the first day's excursion numerous furnaces were seen running with gas blown in through rough, ⅛ in. nozzles; and two or three lines of 5-in. pipe lay on the surface of the railway embankment.

A gas well has lately been opened within the city limits, at a depth of 1,600 feet, on the property of Mr. Westinghouse.

THE TARANTULA OF SOUTHERN CALIFORNIA.

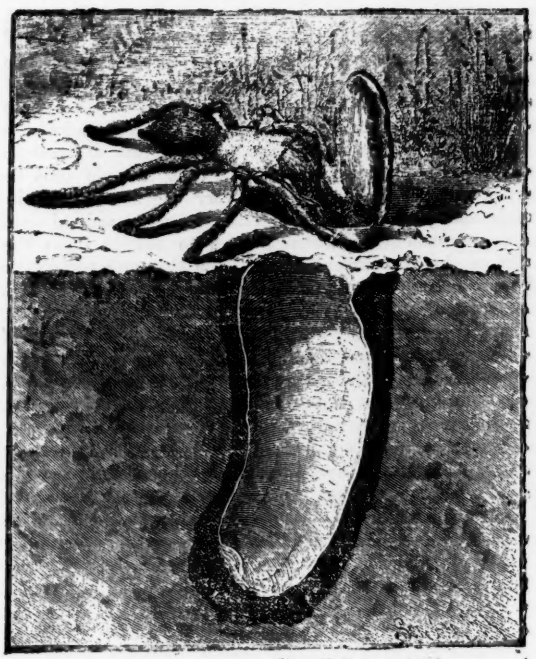
UGLY, vicious, energetic, and to a certain degree poisonous, are the spiders that infest the southern part of California, and yet when closely studied they present many peculiar characteristics, both in regard to their structure and habits. Among the most valued trophies tourists carry away with them from the coast are neat cards adorned with these animals, and a case containing the nest so arranged as to show its wonderful trap-door and the delicate lining of the interior. The adobe ranches are full of these strange little habitations, and some of the sunny valleys among the foot hills are literally strewn with the small tunnels, capped with the almost invisible door. Our engraving shows the tarantula (*Mygale hentzii*) as he is about to enter his abode, both being full size.

The general appearance of the tarantula is very clearly shown in the engraving. The legs are larger, and are not furnished with so long and dense a growth of hair as are the specimens found in other sections of the south-western States. The back is covered very thickly with extremely fine short hair; the back and the outer joints of the legs are of a light brown colour, the remainder being of a deeper shade. The forward part of the head is divided, and each division terminates in a sharp, downwardly curved, and jet black horn or hook.

The tarantula pounces upon his prey, and thrusting in the hooks most securely holds his victim. It is seldom met in the daytime, preferring to seek its food during the night, returning to its nest in the early morning. Although pugnacious when cornered, he will not seek a fight, and is more anxious to escape than the stranger whom he chances to meet.

This tarantula is justly celebrated for the architectural skill he displays and for the luxurious comfort of his dwelling. Having selected a suitable site, he digs a hole varying from four to eighteen inches in depth, and just large enough around to admit him easily, although it is puzzling to conceive how he ever gets his long, ungainly, and many-jointed legs comfortably disposed in so small a space.

The walls are carefully smoothed, and are completely covered with an exceedingly fine fabric of his own manufacture. The top of this tunnel is slightly flared, and in this widened part is fitted the door, which is hinged at one side so that it may be easily lifted. The inside of the door is finely finished, and covered with a web similar to that on the side. The tarantula knows that this door is not heavy enough to ensure a tight fit when it is dropped, so he makes a small handle near the centre of the under side by which he pulls the door closely down, thereby insuring a joint that most effectually excludes all dampness from his abode. The handle is a strong web, the two ends of which are attached to the door at points about one-sixteenth of an inch apart. The outside of the door is placed about at the level of the ground, and is so nearly the same colour as the surrounding



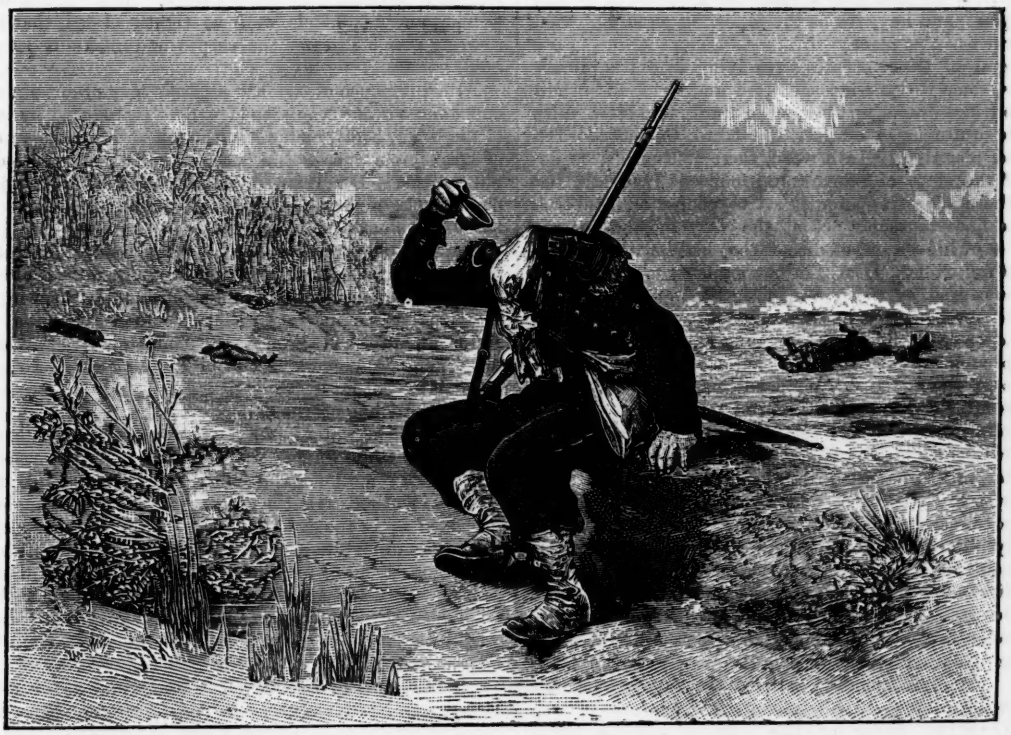
soil that it can be discovered only after the most careful search. The joint of the door is so well made and the colours are so nearly alike that it is almost impossible to ascertain upon which side the hinge is placed, except by raising the door. The framing of the door seems to be a coarse, strong web, which is extended at one side to form the hinge, and which is bonded with earth to give it the requisite stiffness. The hinge is about three eighths of an inch wide, and acts as a spring to shut the door immediately after the owner's exit. For the tarantula and nest from which our engraving was made, we are indebted to the courtesy of Mr. H. J. Finger, of Santa Barbara, Cal.—*Scientific American.*

Remedy for Toothache.—Melt two parts of spermaceti or wax and dissolve in it two parts of chloral hydrate and one part of carbolic acid. Dip pieces of cotton into the mixture and let it cool. For use, detach a small quantity, soften it with a gentle heat, and press it into the hollow tooth.—*Rundsch. f. Pharm.*

ATTITUDES AFTER DEATH.

By C. E. Brown-Séquard.*

AMONG the phenomena sometimes noticed at the hour of death there is one that offers a peculiar interest, and which, up to recent times, has remained a mystery. This phenomenon appears especially, but not exclusively, after a sudden death due either to wounds received upon the field of battle or elsewhere, or to other causes, but almost always when there has been an intense excitement, and often also when great bodily fatigue has preceded the last moment of life. The principal feature of this curious fact is the persistence after death of the expression of the face or of certain attitudes of the limbs or body, or of both.



Such persistence exhibits itself clearly in certain cases; for example, when, despite the sudden cessation of life, a limb that is raised does not drop, or when the body of a man standing, or seated on horseback, does not fall over.

In order to clearly understand the terms of the problem to be solved in reference to this phenomenon, it is absolutely necessary to know (1) that our attitudes and facial expression depend upon a contraction of our muscles due to an influence of the nervous centres, and (2) that such influence necessarily ceasing at the instant of death, a relaxation must also necessarily occur in all the muscles that were contracted, unless some other agency at once replaces that which has disappeared and causes the same physical state to persist that formerly existed therein.

The question, then, is this: What is the agency that, as soon as the faculty of volition vanishes, takes the place of the latter, or at least produces in the muscles an organic state that prevents all relaxation?

The object of this article is to answer this question, and to show that the cause or agency to be discovered is not the sudden appearance of that state of muscular stiffness known by the name of *rigor mortis* or *cadaveric rigidity*, but that such agency is found in a peculiar action of the nervous centres that manifests itself a little before or at the instant of death. One of the most striking examples of the strange fact that I am about to study was observed by Dr. Rossbach, of Wurzburg, upon the battlefield o Beaumont, near Sedan, in 1870. He found the corpse of a soldier half-sitting, half reclining, upon the ground, and delicately holding a tin cup between his thumb and forefinger, and directing it toward a mouth that was wanting. The poor man had, while in this position, been killed by a cannon-ball that took off his head and all of his face except the lower jaw. The body and arms at the instant of death had suddenly taken on a rigidity that caused them to afterward remain in the position that they were in when the head was removed. Twenty-four hours had elapsed since the battle, when Dr. Rossbach found the body in this state. (See engraving.)

In the first work of any importance in which this subject has been treated of, Dr. Chenu relates that a French military surgeon, Dr. Perrier, was greatly surprised upon going over the battle-field of Alma, the day succeeding the terrible conflict, to see that many corpses of Russian soldiers had attitudes and expressions of countenance like those of living persons. Some of these corpses had the different expressions that characterize anguish, suffering, or despair. Others, on the contrary, had the appearance of greater calmness and resignation.

One case particularly attracted the doctor's attention, where the body lay stretched out upon the ground, the knees bent, the hands clasped and lifted in the air, and the

* *La Nature.*

head thrown back, as if death had come upon the individual while he was reciting a prayer. In addition, many other persons who have visited battlefields immediately after a conflict tell us that they observe numbers of corpses that were still holding their guns or sabres. Some seemed to be biting their cartridges, while others, still upon horseback, continued to preserve the attitude they had at the moment of death. These phenomena have been studied with special attention by Dr. Armand at Magenta, by Baron Larrey at Solferino, and by Dr. Baudin at Inkermann.

I owe to the kindness of Dr. S. Weir Mitchell a knowledge of an excellent memoir by Dr. John Brinton, of Philadelphia, upon the "Rigidity which Accompanies Sudden or Violent Death"—a work in which the question under consideration is studied with the greatest care. Speaking of the field of battle of Antietam, Dr. Brinton says that he counted forty corpses over a space of from forty to fifty yards square, and he gives us the following picture of what he observed in this place.

"Several of these corpses were lying in extraordinary attitudes, some with their arms lifted and rigid, and others with their legs drawn up toward the trunk, and stiff. With others, in quite large number, the trunk was curved forward and also rigid. In a word, these attitudes were not those of the state of relaxation produced by death, but rather those of an apparently active character, doubtless due to a final muscular act at the very moment of the extinction of life—a spasmodic act that had left the muscles stiff and inflexible. Death, in the majority of these cases, had been caused by wounds made in the breast; and, less frequently, by balls that had traversed the head or abdomen. In the latter cases there had been considerable hemorrhage, as was proved by the pools of blood of dark colour near the sides of the bodies. This inspection was made thirty-six hours after death, or still later."

The following three cases related by Dr. Brinton (which were furnished to him by friends, are very remarkable :—

A detachment of United States soldiers, foraging around Goldsborough, N.C., came suddenly upon a small band of Southern troopers who had dismounted. These latter immediately jumped into their saddles, and all scampered away except one, after being exposed to one round of fire. The soldier who did not escape was sitting upright, one foot in his stirrup. In his left hand he held the bridle and the horse's mane, while his right hand grasped the barrel of his rifle, near the muzzle, the stock of the gun resting on the ground. The horseman's head was turned toward his right shoulder, apparently watching the approach of the assailing party. Some of the soldiers of the latter were preparing to fire again, when their officer ordered them to desist, and to go and make the defiant man a prisoner. The latter, upon being ordered to surrender, made no answer. When he was approached and examined, it was found that he was dead and rigid in the singular attitude that we have just described. It took a considerable effort to force his left hand to release the horse's mane and to remove the rifle from his right hand. When the body was laid upon the ground, the limbs preserved the same position and the same inflexibility. This man had been struck by two balls fired from Springfield rifles. One of these had entered to the right of the vertebral column, and had made its exit from the body near the region of the heart. It had left its track upon the side of the saddle, and had then dropped to the ground. The other ball had entered through the right temple, and its point of exit could not be found. The horse had remained quiet, as he was fastened by a halter.

The following is another incident: At the battle of Williamsburg, Dr. T. B. Reed examined the body of a United States Zouave who had received a ball in the forehead just as he was climbing over a low fence. He, likewise, had preserved the last attitude of his life. One of his legs was half over the fence, while his body still remained behind. One hand, which was partially closed, was raised level with his forehead, with the palm forward, as if to preserve himself against some imminent danger.

Dr. Henry Stillé relates that, while seated upon a freight car on the Nashville and Chattanooga Railroad, he saw a brakeman instantly killed by a ball which struck him between the eyes, a mortal wound that was given by a guerilla who lay in ambush in a forest through which the train was passing. The man thus killed was tightening the brake when he received the ball. After his death his body remained fixed, the arms extended and stiff on the handwheel of the brake. The pipe which he was smoking remained fastened between his teeth. The rigidity was so perfect, and his hands were so tightly closed, that it was scarcely possible to free the corpse and make it let go its hold.

A maintenance of the last attitude may occur under circumstances other than a sudden death produced by lesions of the brain, heart, or lungs, although an injury to an organ of great importance to life is the most frequent cause of the phenomena. Dr. Brinton has observed it after wounds made in the abdomen, and Dr. Armand, in a single case, through a wound of the thigh.

Yet this phenomenon does not manifest itself exclusively in cases where death results from wounds. It was observed in a horrible accident that happened at London in 1867, when forty-one persons, skating upon Regent's Park Reservoir, perished through the sudden giving way of the ice. The following extract from *The Times* concerning this event is full of interest :—

"The attitude of the majority of the persons who were taken from the water has given rise to numerous discussions in the medical journals. In almost all cases the arms were raised, and sometimes the elbows were pressed against the sides. In other cases the elbows formed a right angle, and projected as in the act of skating. It may be concluded that these unfortunates were resting upon the ice with their arms, not daring to use their hands, and that when, on becoming exhausted, they died, it was not through asphyxia, but rather through the action of cold and fright; and this would explain why they preserved the position in which they were found."

Dr. Taylor had already mentioned the case of an individual who had for a long time held his arms extended to avoid being drowned, and in whom, after death, these limbs were found stiffened out in the same position.

It seems that carbonic acid is capable of producing that special rigidity of the muscles that maintains the trunk and limbs in the attitude that the last act of the will has caused them to assume.

In 1832 Dr. Von Graefe saw, in the grotto of Pyrmont, the corpse of a young man who had voluntarily put an end to his days by exposing himself to the carbonic acid gas that fills this cavern. The body was found half-seated upon the ground. One of the hands supported the head, as if the young man had desired to avoid touching the wall, against which the upper part of his body rested. The trunk was bent toward the right. The attitude of the body had the appearance of a person asleep and reposing peacefully.

How shall we explain this curious series of facts? We know that sooner or later there supervenes a stiffness (called *cadaveric* or *post mortem rigidity*) in all the limbs and all other parts of the body where there are muscles. Is not the stiffness that occurs on the battle-field, and some-

times elsewhere, immediately after death, merely a cadaveric rigidity that has come on suddenly? Those who know the law that I have established concerning the rapidity or retardation of cadaveric rigidity after death (see my Croonian Lecture before the Royal Society of London, 1861) will find it evident that in the majority of the cases of preservation of attitude after death that I have just mentioned, the circumstances were very favourable for the prompt appearance of *post mortem* rigidity. Yet, even the cases placed under the most favourable circumstances, death could not have come on quickly enough to permit of the preservation of an *ante mortem* attitude. This is a sufficient reason to assure us that the fact that we have to explain is not due to the sudden intervention of cadaveric rigidity. But how, then, shall we explain this fact?

Some experiments that I cannot here give the details of have shown me that it is a fixed contraction—a tonic, persistent, muscular action which then occurs, similar to that which it replaces, and which existed during life. At the very moment that death comes on, this fixed or tonic contraction occurs. It is an act of life, but the last one. I have sometimes seen this contraction exhibit itself and then disappear, and it was not till later that the true cadaveric rigidity supervened.

Death, in man as in animals, takes place in two ways that differ radically from each other. On the one hand, it may supervene suddenly, either through the influence of excitement or that of a wound or blow, or, again, through the following causes:—The impression produced by submersion in cold water, or in almost icy water, and the impression produced sometimes, in persons who are eminently nervous, by the least lesion affecting certain parts of the body. In this kind of death there may not be even the least vital manifestation after the last sigh, except a feeble action of the heart that soon disappears. All the cerebral faculties give way suddenly—consciousness, intelligence, the will, the perceptive faculties, sensorial and sensitive impressions, and respiratory motions all disappear at once. There is no *agony*, and none of that struggle that usually precedes death. The body suddenly loses its temperature, and cadaveric rigidity comes late, and lasts considerably.

In the other kind of death, which is the one that we usually observe, there is, on the contrary, a genuine struggle in the still living organism, especially when life is ending through the effect of certain wounds or of a great hæmorrhage, or as a consequence of a complete and sudden deprivation of respiration. The heart in such a case beats violently, the efforts made to breathe are extremely energetic, consciousness and the cerebral faculties may keep up for a short space of time, and after this great agitation or general convulsions occur. The temperature of the body rises, and this increase may still continue for some little time after the last effort made to breathe. Cadaveric rigidity appears early, but never immediately.

My experiments and the details of the cases that I have related show that the persistence of the last attitude does not occur in all cases of death belonging to the first of the two types just described; but facts indicate that this singular phenomenon occurs only in cases of death that belong to this type.

In one of the conclusions of Dr. Brinton's excellent memoir, he says that in the cases of persistence of attitude that have been observed upon the battle-field, and that he describes, death had probably been instantaneous, without being accompanied with convulsions or agony.

It results from the facts that I have studied in this paper, and from the experiments that I have done nothing more than allude to: (1) that the preservation after death of the attitudes of life, and of the facial expression, does not depend upon the sudden appearance of what is called cadaveric or *post mortem* rigidity, but upon the production of a vital act of rigidity or tonic contraction, like the fixed spasm that we often see in hysterical or paralytic persons; and (2) that a number of causes of death, acting without the ordinary agony, may produce that strange phenomenon which is characterised by a persistence after death of the attitude and facial expression that existed at the moment of the last sigh.

OTHER WORLDS THAN OURS.

A WEEK'S CONVERSATION ON THE PLURALITY OF WORLDS.

By Mons. de Fontenelle.

WITH NOTES BY RICHARD A. PROCTOR.

(*Continued from p.* 88.)

"FAIR and softly," says the Marchioness, "I fancy you yourself are seized with the noble fury of astronomy; a little less rapture, and I shall understand you the better. The sun, you say, is in the center of the Universe, and is immovable. What follows next?"

"It is Mercury," said I; "he turns round the sun, so that the sun is the center of the circle wherein Mercury moves. Above Mercury is Venus, who turns also round the sun: after comes the earth, which, being placed higher than Mercury and Venus, makes a greater circle round the sun than either of them. At last come Mars, Jupiter, and Saturn, in the same order I name 'em, so that Saturn has the greatest circle round the sun, which is the reason he is longer in making his revolution than any of the other planets."

"You have forgot the moon," said the Marchioness.

"We shall quickly find her again," said I; "the moon turns round the earth, and does not leave her, but as the earth advances in the circle which she describes about the sun, and if the moon turns round the sun, it is because she will not quit the earth."

"I understand you," said she, "and I love the moon for staying with us when all the other planets abandon us; nay, I fear your German would have willingly taken her away too if he could, for in all his proceedings I find he had a great spite to the earth."

"'Twas well done of him," said I, "to abate the vanity of mankind, who had taken up the best place in the universe, and it pleases me to see the earth in the crouds of the planets."

"Sure," said she, "you do not think their vanity extends itself so far as astronomy! Do you believe you have humbled me, in telling me the earth goes round the sun? For my part, I do not think myself at all the worse for it."

"I confess," said I, "Madam, I believe a fair lady would be much more concerned for her place at a ball, than for her rank in the Universe; and the precedence of two planets will not make half such a noise in the world as that of two ambassadors. However, the same inclination which reigns at a ceremony governs in a system; and if you love the uppermost place in the one, the philosopher desires the center in the other; he flatters himself that all things were made for him, and insensibly believes a matter of pure speculation to be a point of interest."

"This is a calumny," said she, "you have invented against mankind; why did they receive this system if it was so erroneous?"

"I know not," said I; "but I am sure Copernicus himself distrusted the success of his opinion. He was a long time before he would venture to publish it, nor had he done it then without the importunity of his friends. But do you know what became of him? The very day they brought him the first printed sheet of his book he died. He foresaw he should never be able to reconcile all the contradictions, and, therefore, very wisely slipt out of the way."

"I would be just to all the world," said the Marchioness, "but 'tis hard to fancy we move and yet see we do not change our place. We find ourselves in the morning where we lay down at night. Perhaps you will tell me the whole earth moves."

"Yes, certainly," said I; "it is the same case as if you fell asleep in a boat upon the river, when you awake you find yourself in the same place and the same situation in respect to all the parts of the boat."

"'Tis true," she reply'd; "but here's a great difference; when I awake I find another shore, and that shews me my boat hath changed place; but 'tis not the same with the earth. I find all things as I left 'em."

"No, no," said I; "there is another shore too. You know that beyond the circles of the planets are fixed stars; there is our shore. I am upon the earth, and the earth makes a great circle round the sun. I look for the centre of the circle, and see the sun there; then I direct my sight beyond the sun in a right line, and should certainly discover the fixed stars which answer to the sun, but that the light of the sun effaces 'em. But at night I easily perceive the stars which correspond with him in the day, which is exactly the same thing; if the earth did not change its place in the circle where it is, I should see the sun always against the same fixed stars; but when the earth does change its place, the sun must answer to other stars; and there again is your shore, which is always changing. And seeing the earth makes her circle in a year, I see the sun likewise in the space of a year answer successively to the whole circle of the fixed stars, which circle is called the Zodiac. I will draw you the figure of it, if you please, on the sand."

"'Tis no matter," said she. "I can do well enough without it; besides, it will give an air of learning to my park, which I would not have in it. For I have heard of a certain philosopher, who, being shipwreck'd and cast upon an unknown island, seeing several mathematical figures traced on the sea-shore, cry'd out to those that followed him, 'Courage, my companions, the isle is inhabited; behold the footsteps of men:' but you may spare your figures; such footsteps are not decent here."

"I confess, madam," said I, "the footsteps of lovers would better become this place; that is, your name and cypher carv'd on the trees by your adorers."

"Tell not me," said she, "of lovers and adorers; I am for my beloved sun and planets. But how comes it to pass that the sun, as to the fixed stars, compleats his course but in a year, and yet goes over our heads every day."

"Did you never," reply'd I, "observe a bowl on the Green? It runs towards the Jack, and at the same time turns very often round itself, so that the parts which were above are below, and those which were below are above; just so it is with the earth, at the same time that she advances on the circle, which in a year's space she makes round the sun, in twenty-four hours she turns round herself; so that in twenty-four hours every part of the earth loses the sun,* and recovers him again, and as it turns towards the sun, it seems to rise; and as it turns from him, it seems to fall."

"It is very pleasant," said she, "that the earth must take all upon herself, and the sun do nothing. And when the moon, the other planets, and the fixed stars seem to go over our heads every twenty-four hours, you'll say that, too, is only fancy?"

"Mere fancy," said I, "which proceeds from the same cause; for the planets compleat their courses round the sun at unequal times, according to their unequal distances; and that which we see to day answers to a certain point of the Zodiac, or circle of the fixed stars, we see to-morrow answer to another point, because it is advanced on its own circle, as well as we are advanced upon ours. We move, and the planets move too, which must make a great alteration; so that what seems irregular in the planets, proceeds only from our motion, when, in truth, they are all very regular."

"I will suppose 'em so," said the Marchioness; "but I would not have their regularity put the earth to so great trouble; methinks you exact too much activity from so ponderous a mass."

"But," said I, "had you rather that the sun and all the stars, which are vast great bodies, should in twenty-four hours travel such an infinity of miles, and make so prodigious a tour as they needs must, if the earth did not turn round itself every twenty-four hours?"

"Oh," said she, "the sun and the stars are all fire, their motion is not very difficult; but the earth, I fancy, is a little unwieldy."

"That signifies nothing," I replied; "for what do you think of a first-rate ship, which carries near 150 guns, and above 3,000 men, besides great loads of merchandise? yet you see one puff of wind sets her a-sailing, because the water is liquid, and, being easily separated, very little resists the motion of the ship. So the earth, though never so weighty, is as easily borne up by the celestial matter, which is a thousand times more fluid than the water,* and fills all that great space where the planets float; for where would you have the earth fastened to resist the motion of the celestial matter, and not be driven by it? You may as well fancy a little block of wood can withstand the current of a river."

* This, of course, is inexact; being only true at the time of the vernal or autumnal equinox. But it is nearly true of the habitable parts of the earth.—R. P.

* All the reasoning here relates to the system of Vortices.—R. P.

THE INTERNATIONAL HEALTH EXHIBITION.

XI.—WATER AND WATER-SUPPLIES—(*continued*).

WE have now placed before our readers the chief types of water that are commonly derived from both natural and artificial sources. It yet remains to be seen whether any of those crude products are directly available, and how we are to deal with such as are not so, in order to render them fit for domestic purposes, and valuable in various industries and arts.

In the household, the water in this, and all countries with temperate climates, is derived from many different origins. In considering the problem before us, we shall take, as an example, a model tenement provided with every possible convenience and variety of supply; we shall then be able to indicate how the wants of special cases are to be provided for by referring to some particular section of our hypothetically perfect mansion. Imagine, too, that to this abode there is attached a series of typical workshops, each concerned with some special manufacturing process, and that the entire system is furnished with (1) winter reservoirs for the utilisation of snow and ice; (2) tanks for

the collection of rain-water, which may be subject to all kinds of impurity; (3) a lake-water supply, prone to peaty contamination; (4) a source of soft-water derived from upland surface drainage, *e.g.*, the non-calcareous parts of the Coal Measures and the Millstone Grit; (5) a hard-water supply, from a district like that of the basin of the Thames; (6) pump-water from a well on the premises; (7) sea-water.

Domestic requirements would entail a supply of water for the garden, the kitchen, the laundry, the bath-room, and the table; and for each of these it is desirable to procure suitable water from the most ready source, with a minimum of labour and expense. All the waste waters of the household, such as those directly derived from the surface drainage, the kitchen sink, side-gutters, &c., may be conveniently stored in a special brick or stoneware reservoir at the end of a garden, and there treated as required for the irrigation of flower-beds, lawns, and vegetable plots. Of course, in closely-crowded street-houses such waters cannot be utilised, and should therefore find a ready escape into the general sewerage. In like manner, the waste drainage from each factory ought to be stored in some suitable receptacle, where it can be freed from harmful products ere it is allowed to be discharged into streams, rivers, or the soil.

The storage of snow and ice in winter reservoirs has never been generally adopted because of the labour which such a procedure would necessitate if carried out on a large scale; yet we think that there is scope here for country residents to direct some attention to processes which would secure them an ample supply of exceptionally pure water during the colder months of the year. In a paper recently read at the Society of Arts Water-Supply Conference, held in the Exhibition buildings,* Mr. Baldwin Latham records the opinion of Pliny that some prefer "snow-water before that which cometh down in showers, and the water of ice dissolved before the other of melted snow;" and that the rain, snow, and ice, are all lighter than those which spring out of the earth, and ice amongst the rest far lighter than any water in proportion. He also states that, as the result of an extensive series of experiments, upon the degree of purity of frozen waters, which he carried out some years ago: "that the act of freezing may be carried to such an extent as to produce in the remaining water a precipitation of the salts in solution, but ice frozen upon very superficial water was found very liable to have the impurities frozen in it which adhered to the under sides of the ice, and which became embedded in it by subsequent freezing; but water which has been largely deprived of air by boiling or exposure upon being frozen, if perfectly crystalline, will produce absolutely pure water. Several patents have been taken out with a view to freezing sea-water, so as to furnish a supply of fresh water on board ship, but such processes will not compete, from an economical point of view, with the process of distillation."

It is advisable in the case of waters derived from snow and ice, that they should be kept in vessels of stoneware, or other material not liable to be acted upon by the water. There are very many waters which are looked upon as objectionable, because they are too soft for storage in the leaden pipes and cisterns with which the water companies are wont to supply the public. A few days ago, one of our correspondents addressed us with respect to the water-supply of his district. It happened at a period not far distant, that the water became foul through the accession of sewage, and the typhoid germ accordingly grew and multiplied in its strength to an alarming degree. Steps were taken to remedy the evil, when fresh cause for serious apprehension broke out in their midst. The water-supply, derived from the upland drainage of the Coal Measures and the Millstone Grit, was particularly pure and soft, and, as misfortune would have it, also peculiarly avid of lead. Now, we are all aware that it is not the water itself which attacks the lead, for soft waters dissolve metals because they contain, or very soon appropriate various acids and gases, which react upon the metals. Organic substances, especially such humus, ulmic, or other acids, as are likely to accrue from upland surface drainage, act very powerfully on lead. Oxygen, nitrous and nitric acids, all chlorides, and quicklime, also form soluble poisons with lead. The nitrite of ammonia is said to be peculiarly active when it comes into contact with lead; and all these matters are apt to obtain in soft waters. Their presence in small quantities suffices to cause serious metallic contamination; $\frac{1}{100}$th of a grain in a gallon of water may be regarded as an irritant poison. Only $\frac{1}{10}$th of a grain per gallon was discovered in the water which had such evil effects upon the family of Louis Philippe in exile at Claremont, and ended fatally in the case of Vatout, the celebrated librarian. Carbonic acid does not form soluble salts with lead unless in great excess; and the carbonates, sulphates, and particularly the phosphates of lime and magnesia and alkaline phosphates are comparatively harmless (Frankland). Other metals are seldom used for the construction of water-holders; we may, however, mention that injurious effects may arise from zinc, copper, or iron impurities. Tin is sometimes used as a wash over soft iron (so-called "block-tin"), or lead, but is scarcely of any avail, since the decomposition of that metal may not be perceptible, and yet permit of an ingress of the soluble lead or other poison. Tin salts themselves, if taken in moderately large doses,* act as irritant poisons; but, of course, in such cases, which are not at all likely to happen, detection is quite easy.

We have thus dwelt upon the metallic contamination of water, because it is a vexed question to those who are concerned with the supply of water in non-calcareous districts. Such waters may be treated in either of two ways:—they may be hardened to the extent of about five or six degrees by the addition of lime, or the lead must be got rid of in some way or another. The first-mentioned process is, perhaps, the most valuable, since it brings the water to a more generally useful condition from a domestic point of view. The incorporation of a little lime not only prevents the water from taking up lead by appropriating those reagents which act upon the metal, but it also renders the water more suitable for drinking. We may here state that our correspondent has found that the use of the very soft waters of his parish is detrimental to the healthy condition of that most important apparatus in the digestive economy—a thoroughly sound set of teeth; he has, moreover, been in the habit of recommending, in his lectures to the people, the use of oatmeal porridge, especially amongst the young, and we here embrace the opportunity to direct the attention of our readers to his excellent and most wholesome advice, which is, indeed, but an endorsement of the system which has been adopted unconsciously, as the outcome of practical experience, amongst the Scottish Highlanders from times immemorial.

The elimination of lead from poisoned waters by

* "Softening of Water," by Baldwin Latham, M.I.C.E., F.G.S., &c., read July 25, 1884, p. 7.

* Eighteen to twenty-four grains of the chloride given to dogs killed them with symptoms of violent vomiting and general depression in from one to three days. Two grains injected in the blood-vascular system caused death with pronounced tetanus in fifteen minutes, and peculiar tanned post-mortem appearance of the coats of the stomach.

XUM

chemical filtration will be considered in due course when we come to describe some of the contrivances which we have carefully tested in the Exhibition. It seems desirable, however, that leaden pipes, as such, should not be used, and we therefore suggest that the metal might be coated in some way with a siliceous or earthenware glaze, after having been suitably shaped to meet the wants of aquiferous apparatus. It is a subject of such importance, and is brought home to us so forcibly by the many disastrous occurrences of poisonous contamination and the spread of zymotic disease, that we consider it our bounden duty to call the attention of practical workers to the difficulty. We would strongly recommend experiments in this direction to the notice of Messrs. Doulton & Co., of Lambeth.

The uncertainty of an adequate supply of rain-water is a most serious drawback to manufactures in general; but even on a small scale the collection of rain is most desirable. Such water in London alone would save a large annual expenditure for soap used in cleansing operations; and in all towns where the water is naturally very hard rain-water reservoirs must be looked upon as a boon. It occurs, however, that wherever they have hitherto been introduced, as in the Midland counties of England, they are wofully neglected, and come to be, in time, little else than the accumulated liquid filth of roof-drainage.

In the East-central Gallery B, of the Exhibition, devoted to "Water-supply and Purification," Stand 416 has been delegated to Mr. C. G. Roberts, of Haslemere, Surrey, for his "Patent Rain-Water Separator." Fig. 19 shows where

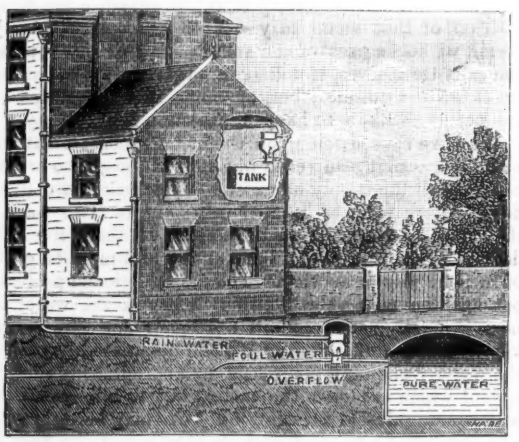


Fig. 19.

this instrument ought to be placed in relation to the system of roof-pipes, etc., of a house; and how provision can be made for the efficient storage of the practically pure water. This innovation so thoroughly fulfils what it has been designed to accomplish, and is moreover so useful an adjunct to every modern dwelling, that we deem it worthy of something more than a passing notice in these pages. It is in reality what it pretends to be, a "water separator," and not a filter; inasmuch as through its action the impure water is rejected and permitted to run to waste, whilst the clear water, deprived of even minute suspended solids is forced to pass to the storage tank or other receptacle.

The water thus secured is well adapted to the wants of the kitchen, laundry, for purposes of ablution and manufacturing processes, and, when filtered, for drinking. The first portion of the rainfall passes into a preliminary box called a strainer, where all the coarser impurities, such as leaves, twigs, &c., are detained, and can be readily removed. From thence the water passes into the first compartment of the separator, through which it flows into the waste-pipe for foul water. After a sufficient time, the rain, which is now considerably purified, owing to the cleansed state of the roof, &c., collects in the second compartment of the separator, which, in consequence, cants or is overturned, so that the future discharge is directed to the pure water reservoir-pipe, as shown in the subjoined explanatory section (Fig. 20).

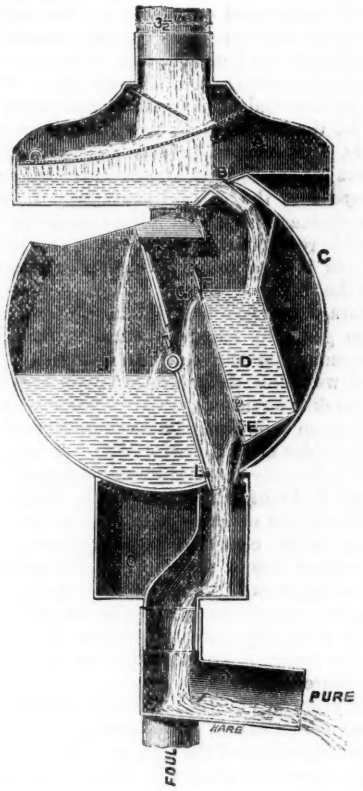


Fig. 20. Section of separator No. 2A in action. Pure water passing to storage. Detailed description of apparatus:—A. Removable strainer with perforated plate to prevent rubbish passing into the separator. B. Outlet for water to pass to separator. C. separator balanced on pivot. D. Small compartment into which the rain-water first falls. E. Small hole fitted with washer proportioned to size of roof. F. Larger hole to take the overflow from D during moderate rain. G. Discharge pipe. In a storm the water fills the compartment D and flows over the top of this pipe. H. Small holes at back of G between compartments. When the rainfall exceeds the discharging capacity of hole E the water rises in compartment D and passing through holes H slowly fills compartment J. When the height of water in J overbalances the separator, it is canted (as shown in drawing) and the water (by that time pure) directed by the discharge-pipe G into the storage-pipe K. L, small hole at bottom of compartment J. M M, auxiliary pipe for keeping compartment J full after the separator is canted when the rain is leaving off, so that the last drop of rain may be stored. By raising the slide N, a third and fourth hole can be opened at H; this will cause the compartment J to fill more rapidly. The whole of th water passes through the discharge-pipe G which conveys it into the waste-pipe O so long as it remains uncanted. The length of time it remains in this position, running the water to waste, is regulated by the slide N to suit the smokiness of the locality. The dotted lines down the centre indicate the position of the iron frame to which the apparatus is attached, provided with holes for fixing to the wall.

Editorial Gossip.

There is no problem in Social Science more nearly affecting the individual citizen than that of assuring the security of his person and the preservation of his liberty. Two cases which have recently been prominently reported in the newspapers seem to point to the fact that the existing law fails very conspicuously to protect either personal liberty, or to afford immunity from wanton and murderous attack.

The first one is that of Mrs. Weldon, which discloses a condition of things that are a simple scandal to our legislation. From what has been brought to light in the High Court of Justice during the past few weeks, it would seem that there is nothing to prevent any person from going to the proprietor of a private lunatic asylum and intimating that he has reason to suspect that the reader of these lines is out of his, or her, mind; nor such proprietor from proceeding with a relation of his own, obtaining access to the said reader under a false pretence, and putting fishing questions for the purpose of establishing that he, or she, is insane. Further, that, having done so, this mad-house keeper may, under the existing law, send two private friends from his own table to certify to the lunacy of the unfortunate reader aforesaid, and upon their certificate lock him, or her, up in his asylum as long as ever it pays him to do so! Surely this discloses a state of things so terrible as to call for searching and immediate reform. No more righteous verdict than that in the case of Weldon *v.* Semple was probably ever delivered; and common-sense Englishmen will only deplore that a decision so conspicuously come to solely on the merits of the case, should stand in the slightest danger of reversal from any of those technical legal quibbles which find their sole defenders in the lawyers who batten on them. *The* remedy for the iniquitous state of things revealed would seem to be the immediate abolition by statute of all private lunatic asylums whatsoever in the United Kingdom.

And if Mrs. Weldon's case illustrates the very precarious tenure upon which we all hold our personal liberty, the shooting by burglars of those two most gallant policemen, Garner and Snell, at Hoxton, equally serves to indicate how the security of the person is sacrificed to sickly and maudlin sentimentality. After the attempted murder of the police constable Chamberlain in the same neighbourhood in June, common sense would have dictated that policemen on night duty there should have been armed. But, oh dear no! They might conceivably under such circumstances have sent a bullet through one of those idols of the Home Office, a ticket-of-leave man, before he had time to fire upon and, perchance, kill them—and that would have been so very shocking! The bull-dog courage, the splendid British pluck which prompted P.C.'s 429 G and 462 G—defenceless, but for a wretched 18-in. ash stick each—to face two murderous ruffians armed with deadly weapons, which they used without hesitation, may well cause a pang of grief and shame to strike everyone who reflects upon the cant and ineptitude which leaves such brave men helpless. A suggestion has been made that armed burglars, when convicted, should have flogging added to their sentences; but, meantime, the death of half-a-dozen of these vermin at the hands of the defenders of the law would do more to stop their nefarious profession than a hundred sentences of a hundred lashes each. Depend upon it, when an armed attack upon the police meant a ·455 bullet through the assailant, "the enterprising burglar" would "cease to burgle" forthwith.

Our Parador Column.

As an example of the pseudo-science with which the unfortunate readers of the *Christian Globe* are fed, we extract the following two paragraphs:—

"So, after all, the 'Man in the moon' is not fiction, but a real flesh-and-blood reality like ourselves. Our little folks, at any rate, will learn the fact with a sense of delight, for all of us in our childhood's days felt a sort of sympathy for the poor old gentleman, condemned, according to the tradition implicitely believed in, to wander about from one year's end to another with his bundle of fagots on his back for gathering firewood on the Sabboth. 'At the astronomical observatory of Berlin,' says a translation from Nya Pressen Helsingfor, 'a discovery has lately been made which, without doubt, will cause the greatest sensation, not only amongst the adepts in science, but even amongst the most learned. Professor Blendmann, in that city, has found, beyond a doubt, that our old friend, the moon, is not a mere lantern which kindly furnishes light for the loving youth and gas companies of our planet, but the abode of living, intelligent beings, for which he is prepared to furnish proofs most convincing. The question has agitated humanity from time immemorial, and has been the object of the greatest interest. But the opinions have always differed very widely, and no two minds held one and the same.'"

"During the last few decades, however, the idea of life on the moon has been held up to ridicule, and totally scorned by men of learning. But, nevertheless, it has now been proved to be correct. By pure accident, Dr. Blendmann found that the observations of the moon gave but very unsatisfactory results, owing to the intensity of the light power of the moon's atmosphere, which is so strong that it affects the correctness of the observations in a very high degree. He then conceived the idea to make the object-glass of the refractor less sensitive to the rays of light, and for this purpose he darkened it with the smoke of camphor. It took months of experimenting before he succeeded in finding his right degree of obscurity of the glass, and when finally found he then with the refractor took a very accurate photo of the moon's surface. This he placed in a sun microscope, which gave the picture a diameter of 55½ feet. The revelation was most startling. It perfectly overturned all hitherto entertained ideas of the moon's surface. Those level plains which formerly were held to be oceans of water proved to be verdant fields, and what formerly were considered mountains turned out as deserts of sand and oceans of water. Towns and habitations of all kinds were plainly discernible, as well—*mirabile dictu*—as signs of industry and traffic. The learned professor's study and observations of old Luna will be repeated every full moon when the sky is clear."

We have heard of Auwers, Förster, Knorre, and Tietjen as astronomers at Berlin, but strongly suspect that "Professor Blendmann" is a species of astronomical "Mrs. Harris." The whole thing reads like a very clumsy reproduction of the famous lunar hoax of which the details will be found in "Myths and Marvels of Astronomy."

Miscellanea.

The Eucalyptus and Water Supply.—Baron Von Mueller has, it is stated, sent to the Victorian Water-supply Department a long report as to the powers of the eucalyptus tree to absorb water, and to condense into water the moisture in the air. He speaks highly of the remarkable powers of these trees in this direction as well established, and urges judicious tree-planting as an auxiliary measure for maintaining and augmenting the water-supply.

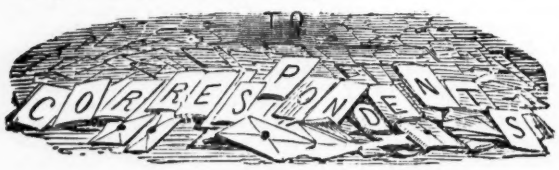
At a recent meeting of the Paris Academy of Sciences, an account was read of a deposit of saltpetre in the neighbourhood of Cochabamba, Bolivia, by M. Sacc. An analysis of this vast deposit, which is large enough to supply the whole of the world with nitrate of potash, yields the following results:—Nitrate of potash, 60·70; borax, with traces of salt and water, 30·70; organic substances, 8·60; total, 100·00. The author concludes that the saltpetre is the result of the decomposition of an enormous deposit of fossil animal remains.

Overhead Wires in London.—According to Sir H. Tyler, no less than 230 overhead wires may be counted beween the Royal Exchange and St. Michael's Church, Cornhill, and 200, more or less, between the Mansion House and Queen-street, the latter being stretched across Queen Victoria-street. A few days since he called the attention of the Secretary of the Local Government Board to these figures. In his reply, this gentleman pointed out, that out of the 230 only six belonged to the Post-office, and of the 200, only four.

A test has been made of balancing a straightedge three feet long and weighing thirteen pounds on a human hair. It was placed on another straightedge, and the hair introduced between the two faces near the centre. The upper one was moved on the hair as a roller until the proper point was reached, when it remained balanced perfectly, so that light could be plainly seen the entire length of the straightedge between the two surfaces, except where the hair separated them at the middle of their length.—*Scientific American.*

From the annual report of the Metropolitan Board of Works for 1883 it appears that the staff of the London Fire Brigade consists of 670 men. The number of firemen employed on the several watches kept up throughout the metropolis is at present 108 by day, and 253 by night, making a total of 361 in every 24 hours; the remaining men are available for general work at fires. The number of calls for fires, or supposed fires, received during the year was 2,630. Of these 337 were false alarms, 149 proved to be only chimney alarms, and 2,144 were calls for fires, of which 184 resulted in serious damage, and 1,960 in slight damage. The fires of 1883, compared with those of 1882, show an increase of 218; and, compared with the average of the last ten years, an increase of 446.

Use of Disinfectants in Paris.—Experiments in the disinfecting of rooms have been carried on in a Paris hospital, and many have witnessed the experiments conducted by Drs. Pasteur and Dujardin-Beaumetz. At present two systems are under discussion—the use of the liquid sulphurous anhydride and the simple burning of sulphur. At first the sulphur would not burn, and the acid, though it told on the litmus test-papers, did not kill the microbes which M. Pasteur had left in the room. Now, however, by pouring a little alcohol over the sulphur, it has been made to burn very successfully, and by using a larger quantity of the disinfectant, whether in a liquid or a solid state, the microbes were killed. Both the rooms measured 98 cubic mètres, and 2 kilos. of sulphur had to be burnt before the living organisms left in the room were destroyed. This is about the same amount which long experience in England has proved to be necessary.



"Let Knowledge grow from more to more."—Alfred Tennyson.

Only a small proportion of Letters received can possibly be inserted. Correspondents must not be offended, therefore, should their letters not appear.

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VENUS IN A THREE-INCH TELESCOPE.

[1356]—I should like to ask readers of my paper on p. 92, to float a pale wash of Indian ink over the inner (the upright or right-hand) edge of Venus as shown in the woodcut (Fig. 1.) on that page, so as to cause it to melt, as it were, into the surrounding sky. The engraver has removed the shading from it, and erroneously left it too sharp and bright.

A Fellow of the Royal Astronomical Society.

MIND AND BRAIN.

[1357]—Your very fair critique on Büchner's "Force and Matter" contains one remark on which you will, perhaps, permit me to say a word—viz., that it is inconceivable "that thought, &c., *is* motion in matter." To me this seems to follow clearly; for if it is proved that no motion of brain-matter, no thought, is a truth—and Haeckel, Hurohke, Vogt, and other eminent scientists clearly say so—it appears to me *very* conceivable and reasonable to say that thought is a mode of motion of the molecules of the brain.

The more perfect the brain the more complicated these movements, the deeper the thoughts, seems to follow as a matter of logic.

From the simple movements of attraction and repulsion, the loves and hates of matter, it is conceivable to me to trace the gradual development of thought movements *pari passu* with the physical development of the human brain in course of evolution through immense periods. F. W. H.

[I may be as obtuse as F. W. H. appears to consider that the Reviewer of Büchner's work is, but I confess that I fail to see that because (as is indubitable) no thought occurs—or can occur—without motion of brain matter—ergo—such motion *is* itself thought. No tune was, or conceivably ever could be, played upon an organ without the movement of the keys, bellows, &c., but it would appear an old mode of reasoning to predicate that such movement was the tune itself.—Ed.]

FLORAL PARASITISM.

[1358]—During the past spring I have had a fine specimen of *Orobanche minor* make its appearance in a flower-pot containing a double pink geranium, and placed at a window in a sitting-room.

When it had finished flowering I examined the root. It had firmly engrafted itself on the root of its host, which had made but little growth, and no recent roots at all.

Is it not unusual for *orobanche* to establish itself on such a plant as a geranium? Wm. H. Allen.

[The *orobanchaceæ* are all parasitical on the roots of plants; but they mostly attach themselves to wild ones. Yours does seem rather a singular instance.—Ed.]

LETTERS RECEIVED AND SHORT ANSWERS.

Nigel Doble.—A 4-in. object-glass of 66 in. focus ought to suit your purpose. You understand, of course, that for the eye-pieces of which I gave the details on page 79 to give the magnifying powers set against them, it is imperative that they should be employed with an objective of that focal length. Any alteration in that respect would involve a corresponding alteration in their respective powers of amplification. I neither can nor will recommend tradesmen. The firm you mention only sell—they do not make—object-glasses.—A. Roberts. See what you can do with λ Ophiuchi. This is a *very* severe test for an instrument of the size of yours. τ in the same constellation is, I am afraid, just beyond your instrumental capabilities. Try too the double-double star ε^1 and ε^2 Lyræ, and see how many stars you can make out between the two pairs.—G. H. Robertson inquires what is the chemical composition of the substance called "Essence d'Orient" used in the manufacture of artificial pearls. Can any of our readers inform him? I suppose he does not mean the powdered bleak or minnow scales with which glass beads are internally coated to imitate pearls?—Anonymous (Bradford). Thanks for the cutting from *Le Temps* containing M. Cotteau's essay on the Krakatoa eruption. It tells in the picturesque French fashion what has appeared in print in other forms over and over again.—John Branch sends me a letter from "Enquirer" with reference to Spiritualism, which is very much too long for insertion. Some years since, impressed to a certain extent by the blatant assertions of so-called "Spiritualists," I investigated the question thoroughly for my own satisfaction; and am hence in a position to reply to, at all events, some of "Enquirer's" queries. Imprimis, neither furniture nor anything else ever moves unless it is pushed or lifted by human agency. In the next place, the whole of the race of mediums (save a very small percentage, indeed, who are insane) are arrant rascals; who, as I have said before in these columns, ought, one and all, to be prosecuted under 5 Geo. IV., c. 83, s. 4. And lastly, do not let "Enquirer" delude himself with the belief that he will be suffered to conduct any experiments in a scientific (to say nothing of a common-sense) fashion. If the "Spiritualists" forming the "circle," find out that he is sceptical, and likely to detect the vile cheat who trades upon the holiest feelings of our nature by pretending to communicate with our loved dead ones, he is told that "his influences are antagonistic," and that he must shift his place in the circle, &c., and so he is wedged in between people who take exceedingly good care that he is in no position to lay hold of the medium himself, that medium's paper tube, or anything else that may be "floating" about in the dark. I declare that I have sat in a sort of dumb wonder at the fatuous and idiotic manner in which believers have gone two-thirds of the way to meet the imposture of the medium, when I have been present at a *séance*, the indifferently-performed conjuring tricks of such mediums having been received by these *gobe-mouches* as the veritable acts of beings from another sphere! I have said before, though, and must here repeat, that I cannot

have the valuable space of KNOWLEDGE wasted in the discussion of an imposture which is simply a disgrace to the boasted intellectual advancement of the nineteenth century.—FIDES. I regret to say that I am ignorant of the correspondence class to which you refer. It was apparently a private adventure, possessing no official character whatever.—SYDNEY POCKLINGTON. To give the objects described as observed with a three-inch telescope, as seen in a two-inch one, would be simply to show them a very little smaller, and not quite so well-defined; the closest separable double stars, for example, in the large instrument merging into misshapen single ones in the smaller telescope. It would be the veriest waste of space.—AN ANONYMOUS CORRESPONDENT sends us the *Times* obituary for July 29, as containing this coincidence:—"On the 25th inst., at Delverton-road, Manor-place, Walworth, John *Lightning* Morgue, aged 75," and "On the 26th July, after three years' suffering, Margaret, wife of Captain George *Thunder*, aged 34." These names are sufficiently uncommon to read oddly in such connection.—A CONSTANT READER. I have nothing to add to what I said about Professor Loisette's system in No. 117. You must hence judge of its applicability to your own case. If by "Abstract English History," you mean a cram-book, I can recommend none such. Dr. Wm. Smith's "Smaller English History," though, ought to answer your purpose. Stewart's "Modern Geography," too, published by Oliver & Boyd, will give you a sound grounding in the subject of which it treats.—H. FRANCIS. Your "Coincidence" is of too doubtful a character to warrant me in wasting space by its insertion. You will see your extracts from the *Christian Globe* elsewhere. There is not a trace either of air or water upon the Lunar surface. Did the latter exist, its evaporation must, perforce, form clouds. Of course, the Moon appears inverted as viewed from the Southern hemisphere, *i.e.*, when we are looking at, say, the "Metropolitan Crater" Tycho, in England with the naked eye, it appears to be at the bottom of the Moon; while, as viewed from New Zealand, it is at the top. Your difficulty about what you call the "axial inclination" of the Moon, arises wholly from the fact that her diurnal path is not parallel to the horizon. For a cognate reason the Great Cross in the Constellation Cygnus rises in these latitudes horizontally and sets perpendicularly.—J. MURRAY has had an octagonal tin reflector made, and finds that it gives a number of dim blotches of light when a candle is placed 20 inches from its centre. This, he seems to conceive, affords some sort of explanation of Sunspots! Like the lamented Artemus Ward, however, "I don't see where the larfture comes in myself."—EXCELSIOR. The *Sidereal Messenger* is published at the Carleton College Observatory, Northfield, Minn., U.S. I do not know whether either of the American publishers in London would be able to obtain a single number for you. It is a subscription serial.—MARS. Newcomb's "Popular Astronomy" is an admirable book. By all means get it.—ALGERNON BRAY. The words which you quote were used in connection with the enormous amount of painstaking work bestowed upon the production of the magic cube. I willingly repeat them in connection with the specimen which you send me. You will perhaps give me credit for knowing how much—or how little—*mathematical* difficulty is attendant on such calculations. "X.'s" cube contains once each number from 1 to 1,331 inclusive.—R. E. O'CALLAGHAN asks me to correct the statement on p. 97 that the National Food Reform Society is a Vegetarian Association; inasmuch as it permits the use of eggs, milk, cheese, and butter. Possibly the reviewer may have been misled by the short manifesto of the society, which heads all its publications: "National Food Reform Society." — Objects: "To circulate useful information regarding healthful, cheap, and natural articles of diet; to promote thrift in food—temperance in eating—and the use of grains, fruits, nuts, and other products of the vegetable kingdom as essential articles of diet; and to advocate abstinence from flesh of mammals, birds, and fish;" and it may also be that the eggs, milk, cheese, and butter, part of its programme, was not prominently insisted upon (even if there was a single syllable about it) in the "Magazine" noticed.—R. F. H. To answer your queries in detail here would be impossible. The pole star at the date of the erection of the Great Pyramid was *a* Draconis, and *not* Orion, as you imagine. The pole of the heavens in these latitudes is the point towards which the northern end of the earth's axis is directed. Now, the polar radius of the earth describes a cone in space in the course of 25694·8 years, or, putting it another way, the pole of the equator revolves round the pole of the ecliptic in that time. Hence the pole star for the time being will be that star most nearly vertical over the north pole of the earth. To the rest of your questions you will find categorical replies in my "Universe of Stars," published by Longmans & Co. I may add, by the bye, that the companion to Polaris has preserved sensibly the same distance from its primary ever since its discovery, but that it seems to be moving very slowly round that primary in a direction opposite to that of the hands of a watch.

Our Mathematical Column.

NOTES ON EUCLID'S SECOND BOOK.

By RICHARD A. PROCTOR.

(Continued from p. 80.)

PROP. II.—*To produce a given straight line* (A B) *so that the rectangle contained by the whole line thus produced and the given straight line may be equal to the square on the part produced.*

Produce A B to C and D, making B C equal to C D equal to A B. Divide C D in E so that the rectangle C D, D E may be equal to the square on C E. Then the rectangle A E, A B shall be equal to the square on B E.

For the square on B E is equal to the squares on B C, C E, together with twice the rectangle B C, C E; that is, to the square on A B, the rectangle C D, D E (*const*), and twice the rectangle A B, C E; that is, to the rectangle contained by A B, and the line made up of A B, D E, and twice C E. But the sum of these lines is equal to A B, C D, and C E together, that is, to A B, B C, and C E, or to A E. Hence the square on B E is equal to the rectangle A E, A B.

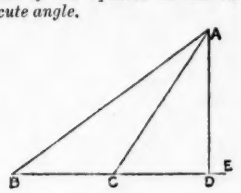
Props. 11 and II. correspond to the two solutions of the quadratic

$$a\,(a-x)-x^2$$

which results as the analytical expression of the relation in Prop. 11, when A B is made equal to a, and the smaller section of A B equal to x.

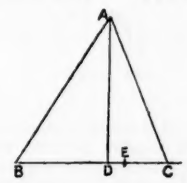
Props. 12 and 13 are important in solving geometrical problems of a certain class, though Euclid himself makes no use of these propositions. Each has a *general* and also an *exact* converse theorem. The general theorem converse to Prop. 12 is this:—*If the square on one side of a triangle is greater than the sum of the squares on the other two sides, these two sides contain an obtuse angle.* The proof is simple; the angle contained by the two sides must either be acute, right, or obtuse. If it were acute, then by Euc. X., Bk. II., 13, the squares on the sides containing this angle would together be greater than the square on the remaining side, but they are not greater; if it were right, the squares on the sides containing this angle would together be equal to the square on the remaining side; but they are not equal to this square. Therefore the angle is obtuse.

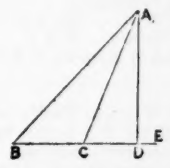
And in like manner may be proved the theorem converse to Prop. 13, viz.,—*If the square on one side of a triangle be greater than the sum of the squares on the remaining sides these sides contain an acute angle.*



These two props. may be referred to as Euc. II., Props. 12 and 13, *gen. conv.*

The exact converse theorem to Prop. 12 is this,—*If* A C B *be an obtuse angle, and* B C *be produced to* D, *so that the squares on* B C *and* A C *with twice the rectangle* B C, C D *are equal to the square on* A B, *then* A D *is perpendicular to* B D. This property is often useful, as is the corresponding property converse to Prop. 13, viz.,—*If* A B C *be an acute angle and a point* D *is taken in* B C (*produced if necessary*), *such*





that the squares on A B *and* B C *together exceed the square on* A C *by twice the rectangle* B C, B D, *then* A D *is perpendicular to* B D. The proof in either case is easy, for in the first case, if the foot of the perpendicular from A on B C produced, fell otherwise than at D—at E suppose, it can be readily shown to follow from Prop. 12 that C D is equal to C E, which is absurd: and similarly in the second case we can show (if E is the foot of the perpendicular from A) that B E is equal to B D.

These propositions may be referred to as Euc. Bk. II., Props. 12, 13, *ex. conv.*

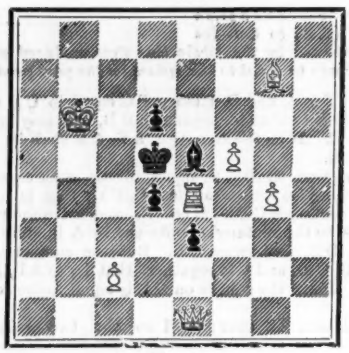
Our Chess Column.

By Mephisto.

PROBLEM, No. 122.

By T. Simmonds.

Black.



White.

White to play and mate in three moves.

SOLUTION OF PROBLEM, p. 80.

1. P to Q3 — 1. P takes P
2. R to B. 4 — 2. K takes R
3. B to K6 (mate).

If 2. Kt takes R

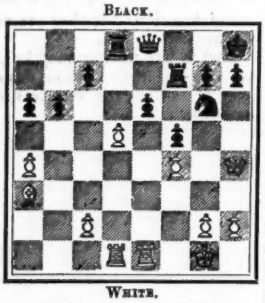
3. B to Kt7 (mate).

One of three games played blindfold by Mr. Gunsberg on the 29th of July at the residence of Dr. J. Hunt.

White. E. Dale.	Black. Gunsberg.
1. P to K4	P to K4
2. Kt to KB3	Kt to KB3
3. Kt to QB3	Kt to QB3 (*a*)
4. B to Kt5	P to QR3
5. B to R4	B to B4 (*b*)
6. Kt × KP	Kt × Kt (*c*)
7. P to Q4	B to QKt5 (*d*)
8. P × Kt	Kt × P
9. Q to Q4	B × Kt (ch)
10. P × B	Kt to Kt4
11. Castles (*e*)	Kt to K3
12. Q to KKt4	Castles
13. B to Kt3	K to R sq. (*f*)
14. P to QR4	P to KB4 (*g*)
15. Q to Kt3	P to QKt3 (*h*)
16. B to QB3	R to B2 (*i*)
17. QR to Q sq.	Q to K sq.
18. P to KB4	B to Kt2
19. B to Q5	B to B3 (*j*)
20. P to B4	R to Q sq.
21. Q to KR4(*k*)	B × B (*l*)
22. P × B	Kt to B sq.
23. P to K6	P × P
24. KR to K sq.	Kt to Kt3 (*m*)

Position after Black's 24th move.

Black.



White.

White. E. Dale.	Black. Gunsberg.
25. Q × R (*n*)	Q × Q
26. P × P	R to B sq. (*o*)
27. P to K7 !	Q to B sq. (*p*)
28. P × R (ch)	Kt × P
29. B to K7	Kt to Q2
30. R to K5(*q*)	P to Kt3
31. R to Q5	Resigns.

NOTES.

(*a*) If it was Black's intention to avoid the complications arising out of the Ruy Lopez, by playing the Russian Defence, then he ought to have continued with 3. B to Kt5; to this, White's best reply seems to be 4. Kt takes P (for if 4. P to Q3 then P to Q4), B takes Kt. 5. QP takes B, Kt takes P. 6. B to Q3, Kt to B3. 7. Castles, Castles with an even game. The move in the text transforms the opening into a four Knights' game.

(*b*) Some German analysts consider 5. B to K2 to be Black's best reply. If White now or in his previous move plays B takes Kt, then QP takes Kt; Kt takes P, Kt takes P; Kt takes Kt, Q to Q5; and Black can equalise the game. In reply to B to K2, White might play 6. P to Q3, P to KKt4. 7. B to Kt3, P to Q3, &c.

(*c*) There is no advantage to be gained by B takes P (ch), for although compelled to play K to Kt sq., later on White will obtain a strong centre by P to Q4, and, subsequently, a good development.

(*d*) There is not much satisfaction to be got from 7. B to Q3, as given by the books, as White comes very strong with 8. P to KB4, Kt to Kt3. 9. P to K5, B to K2. 10. P to B5, &c.

(*e*) Here 11. B to R3 appears to be very strong.

(*f*) Black's proper reply was 13. P to Q4, threatening Kt to B4, and to exchange the B for the Kt, after which a draw is certain; if P takes P *en passent*, Q takes P, and White has no perceptible advantage.

(*g*) 14. P to KB3 was admissible.

(*h*) Seeking to place the QB, but that leaves the QP weak.

(*i*) 16. R to K sq. might have answered better, but Black's position is weak.

(*j*) B takes B was the correct reply, and after R takes B, Black, although having a cramped game, would have been able to defend himself.

(*k*) A very good move, White threatens B takes Kt, and neither the P nor the Q could then retake.

(*l*) Anything but that. Black might have retired his QR to Kt sq.

(*m*) Black had a satisfactory reply in 24. R to B3, *i.e.*

23.	R to B3		
24. P takes P	R takes R	or, B takes Kt	Q takes B
25. R takes R	R takes P	P takes P	R takes R, &c.

leaving Black with the better game for the ending.

(*n*) This move is as ingenious as it is sound. Mr. Dale has on more than one occasion shown that he is capable of playing in first-rate style.

(*o*) If Q moves, P takes R, and the R threatens mate.

(*p*) If 27. Kt takes P. 28. R takes Q, R takes R. 29. B takes Kt, remaining with two Pawns against the B, perhaps Black's best course.

(*q*) If 30. Kt takes R, then P takes Kt, first followed by R to Q8.

"THE CHESS-PLAYERS NOTE-BOOK."*

We were very pleased with this little book, which is well got up, and contains Diagrams, Letters for sending solutions, Game records, and tables for noting down results. There is a very good shilling's-worth in this useful little book of 150 pages.

ANSWERS TO CORRESPONDENTS.

*** *Please address Chess Editor.*

Minasoto.—The K must never be in check.

T. Simmonds.—Ending received with thanks.

Correct solutions received, Problem, p. 80:—J. K. Milne—A. W. Overton. Problem No. 120: C. T. G., E. Ridgway, George Gouge, Donna, T. Simmonds, John Watson, Uncle John, Minasoto, A. J. Howard. Problem No. 121: The Owl, A. J. Howard, Minasoto, S. B. C., Uncle John, John Watson, Geo. Thompson, T. Simmonds, C. T. G., Donna, George Gouge, E. Ridgway, J. K. Milne. Ending, p. 102: C. T. G., G. Thompson, John Watson.

* Rhodes Marriott, 95, Clifton-street, Manchester.

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